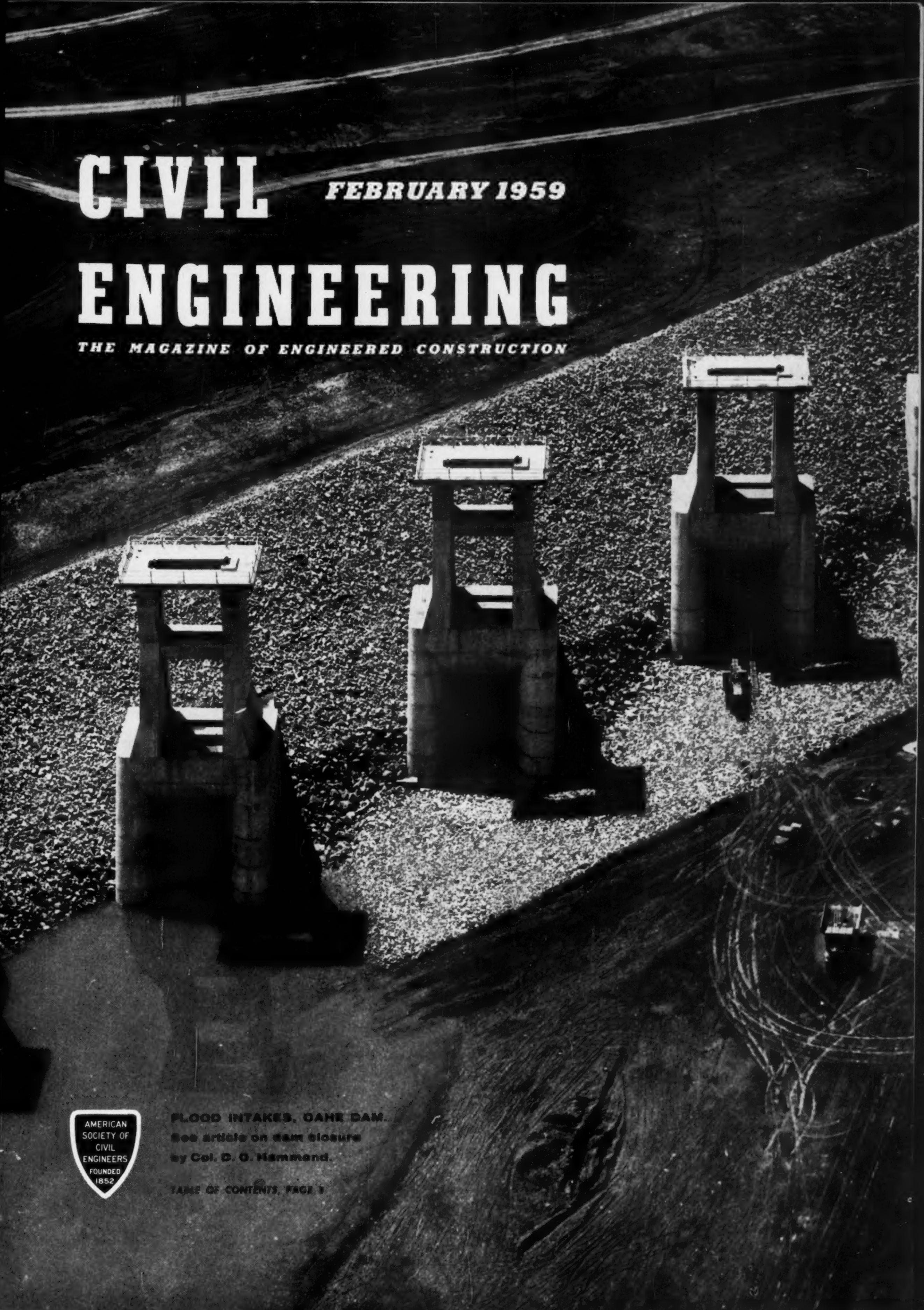
CIVIL ENGINEERING

FEBRUARY 1959

THE MAGAZINE OF ENGINEERED CONSTRUCTION



AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

FLOOD INTAKES, OAHE DAM.
See article on dam closure
by Col. D. O. Hammond.

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NEW! Cast Iron That Bends Under Stress!

AMERICAN DUCTILE IRON

A new super-service line of pipe, tubing, casing, fittings and special castings has been developed by the American Cast Iron Pipe Company and designed to meet the special service requirements of high internal pressures, heavy external loads and extreme shock. This new line of products is produced of AMERICAN DUCTILE Iron.

Another in a long list of AMERICAN "firsts," AMERICAN DUCTILE Iron products are the first of their type to be manufactured in commercial quantities in the United States. Already widely accepted, many thousands of feet of AMERICAN DUCTILE Iron pipe are now in service throughout the country.

AMERICAN DUCTILE Iron offers the proven corrosion resistance of gray cast iron combined with ductile characteristic approaching those of steel. This combination assures long service life, extraordinary dependability and increased factors of safety for extreme service conditions.

Get detailed information on AMERICAN DUCTILE Iron products, including grades, specifications, tests and representative materials produced of this unusual metal. Call or write the American Cast Iron Pipe Company sales office or representative nearest you.

STRENGTH—Withstands internal pressures and external loads

TOUGHNESS—Absorbs shock and stress

DUCTILITY—Bends and twists under load . . . but doesn't break

LONG LIFE—Excellent corrosion resistance . . . confirmed by tests

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BIRMINGHAM ALABAMA

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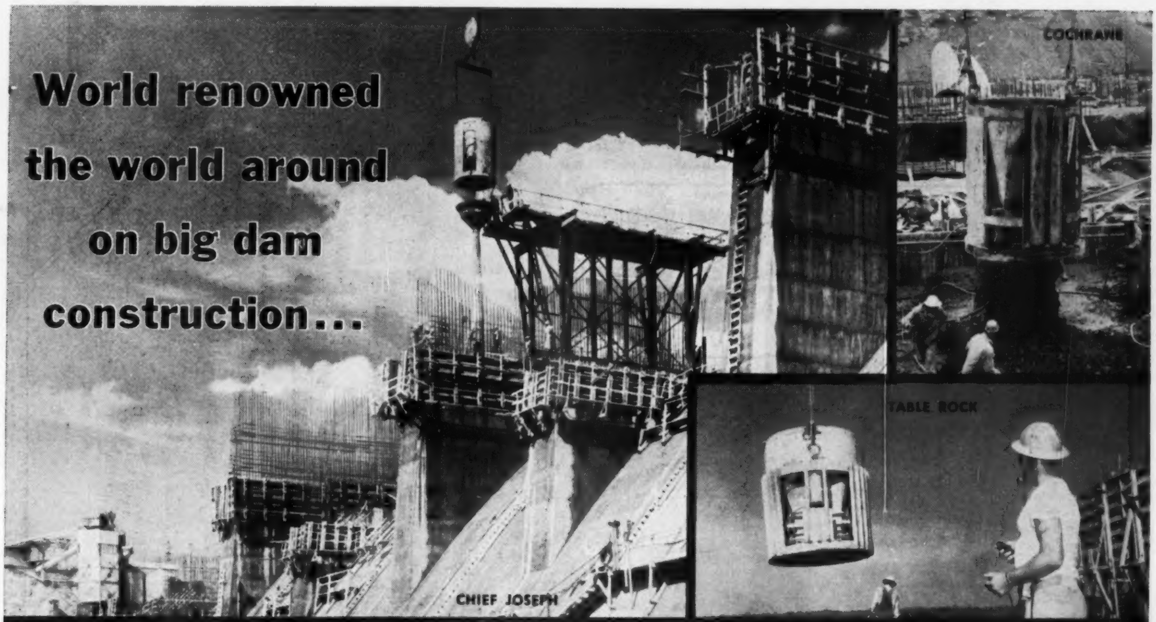

GAR-BRO CONCRETE BUCKETS

ON MORE THAN 80% of all large dam projects, Gar-Bro's big, heavy-duty concrete buckets have been used. Gar-Bro's remote controlled, air-operated gates and the new power operated crane hooks have become essential on these projects. As an innovation, Gar-Bro concrete buckets on cableways have been guided and controlled by closed circuit television and short wave radio.

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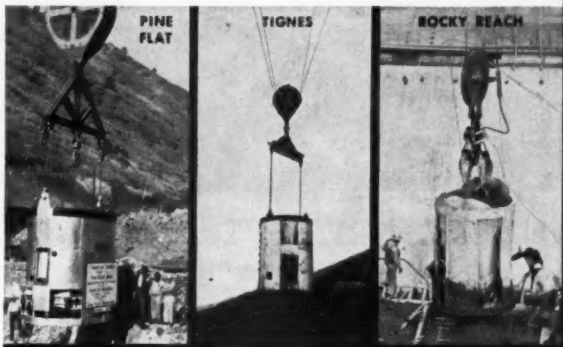
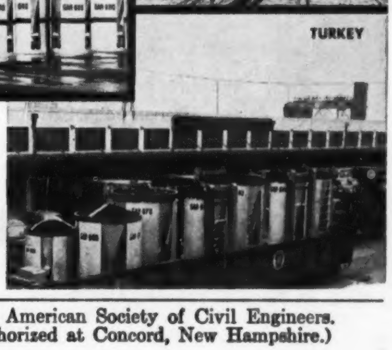
**Presently under construction—see Gar-Bro buckets in action.*





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EQUIPMENT GAR-BRO ENGINEERING SERVICE

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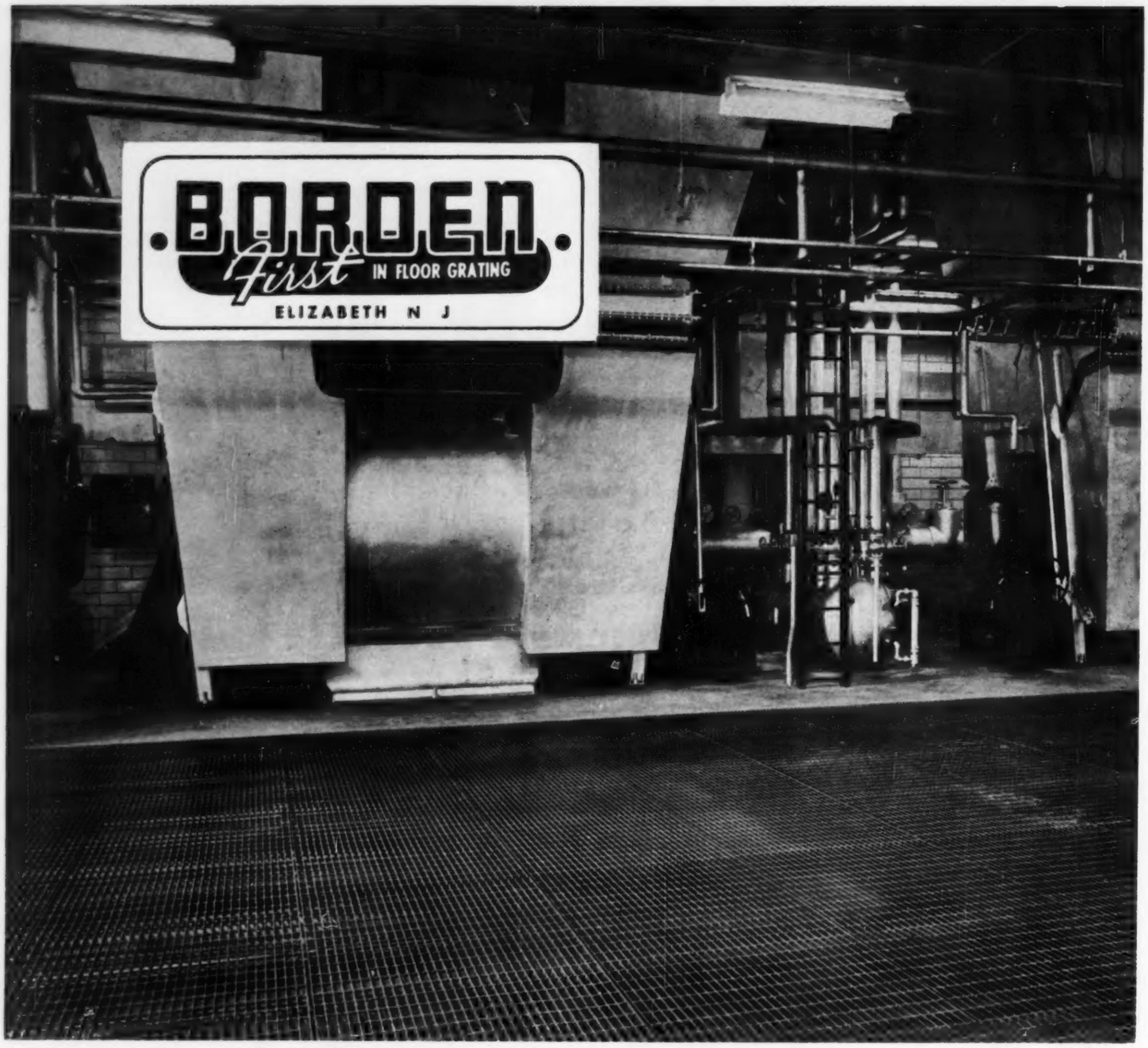

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"Transite's installation recent increases

Says Philip J. Holton, Jr.
Chief Engineer
Water Supply Board
Providence, R.I.

"Our records show that labor and material costs have increased 100% since 1946. Yet, in this same period of time, our installation costs have increased only 21%. The ease of handling and speed with which contractors can lay Transite Pipe enable us to take full advantage of modern equipment and methods. In this way, Transite has played a prominent part in helping us offset increased costs."

Transite Pressure Pipe helps you cut system costs 3 ways: in design . . . installation . . . operation!

Today, in every part of the nation, municipal and consulting engineers choose Transite® Pressure Pipe. Ask why, and you find that economy is always among the Transite advantages they consider most important. For no pipe does so much to help keep your costs low in three different areas:

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2. Installation. Transite's installation speed cuts time and labor costs substantially. Light in weight for so durable a pipe, it handles easily above and below ground. And its Ring-Tite Coupling assembles quickly, surely . . . giving you a tight seal at every coupling in the system.

savings have helped us absorb in labor and material costs..."

Crews of Fanning and Doorley Construction Co. installing 8" line in Providence, R. I.

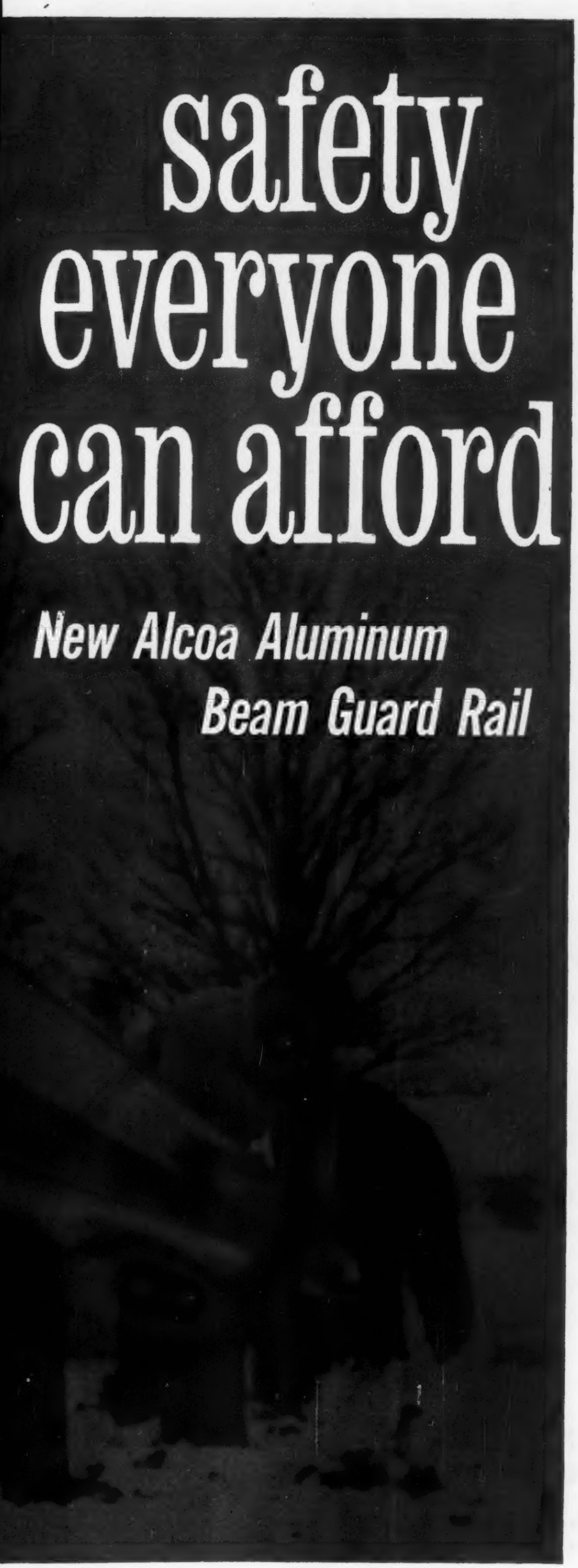
3. Operation. Here's where Transite really saves! For its maintained carrying capacity keeps pumping costs low year after year. Its strength, durability and corrosion resistance cut maintenance to a minimum, provide years of trouble-free service.

Transite's Ring-Tite Coupling cut away to show how rubber rings are compressed and locked in place to form a tight yet flexible joint.

We'll be pleased to send you booklet TR-160A. Write Johns-Manville, CE Box 14, N.Y. 16, N.Y.

"Good Water, the Lifeblood of your Community" Let's promote it—Let's have it!

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

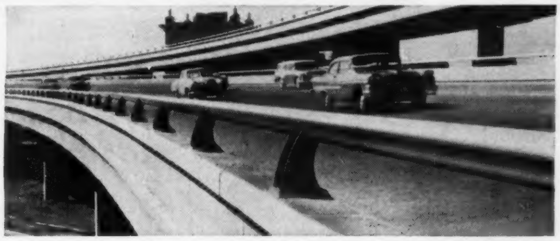


Alcoa's new aluminum beam guard rail for highways combines maximum safety with modern appearance and minimum upkeep. Fabrication from high-strength aluminum alloys assures increased energy absorptive capacity.

Alclad aluminum provides permanent resistance to corrosion and means direct savings in maintenance costs. It resists the corrosive effects of road salts, industrial fumes and airborne grit. No painting—on or after installation—is necessary. Initial cost, only slightly higher than ordinary guard rail, is rapidly equalized by the savings in painting and other maintenance. Alcoa® Beam Guard Rail is available with aluminum posts, too.

Now is the time to get the full story on Alcoa Beam Guard Rail, Lighting Standards, Highway Signs, Overhead Structures and Chain Link Fencing. To learn how they help stretch taxpayers' highway dollars, call your nearest Alcoa sales office or write: Aluminum Company of America, 1913-B Alcoa Building, Pittsburgh 19, Pennsylvania.

BRIDGE RAILINGS of Alcoa Aluminum deliver maximum return for tax dollars, because first cost is last cost. Lightweight aluminum is easier to handle and faster to erect. Corrosion-resistant Alcoa alloys never need maintenance; they end painting costs that commonly run to a dollar per lineal foot per year.



OVERHEAD SIGN STRUCTURES eliminate periodic maintenance and the accompanying traffic tie-ups when they're built of Alcoa Aluminum. Tubular truss designs and single-chord spans meet any requirement and their lightness permits faster erection with minimum man power and equipment.

ALCOA ALUMINUM
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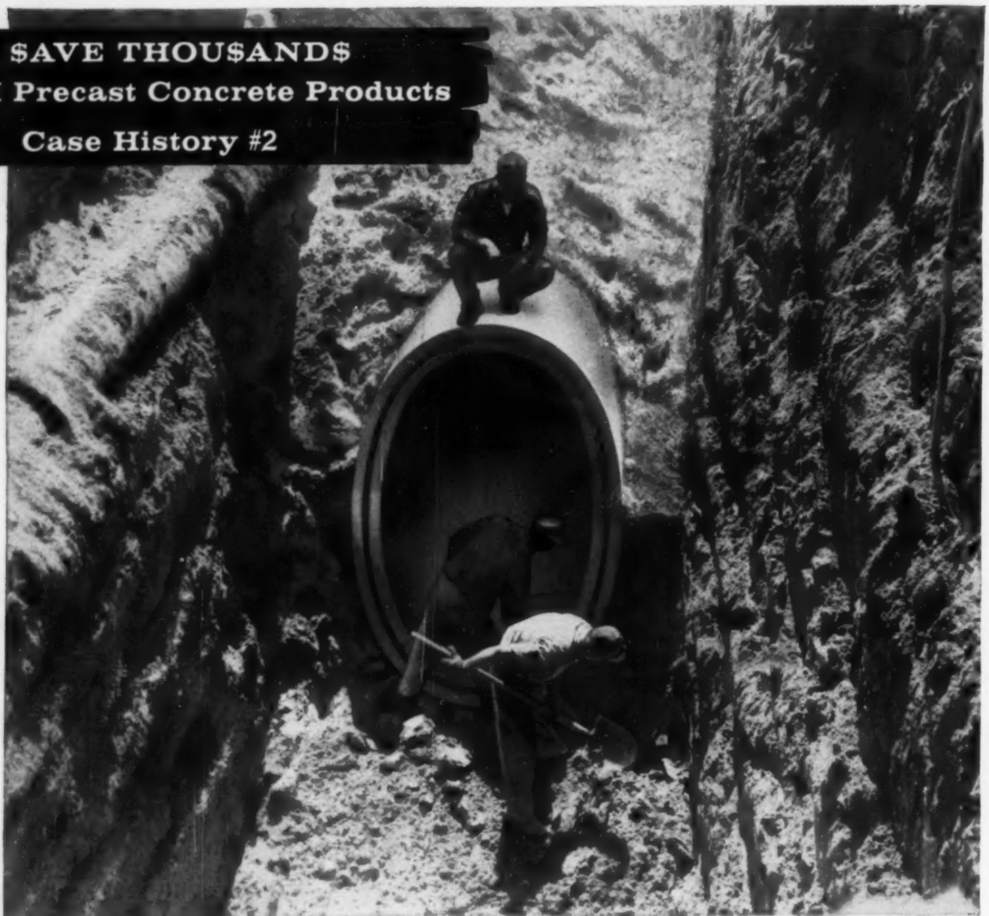
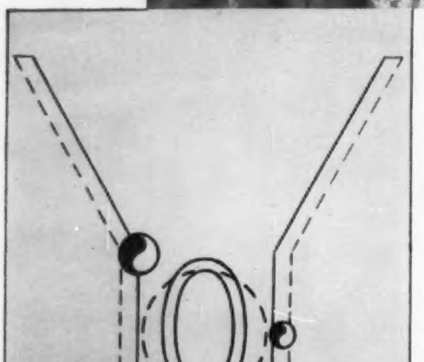
Your Guide to the Best in Aluminum Value

For Exciting Drama Watch **"Alcoa Theatre,"** Alternate Mondays, **NBC-TV** and **"Alcoa Presents,"** Every Tuesday, **ABC-TV**

INCHE$ $AVE THOU$AND$
with A-M Precast Concrete Products
Case History #2





Existing water and gas mains limit trench width of Pontiac, Michigan storm sewer. HI-HED provides greater capacity within a workable area.

A-M HI-HED® PIPE CUTS EXCAVATION COSTS DRASTICALLY!

- 18% narrower than equivalent round pipe, HI-HED Pipe cuts valuable inches from trench widths—can save contractors thousands of dollars in excavation costs.
- HI-HED saves customers the expense of removing or relocating utility lines.
- Another bonus benefit—HI-HED pipe design means higher velocities at low flow.

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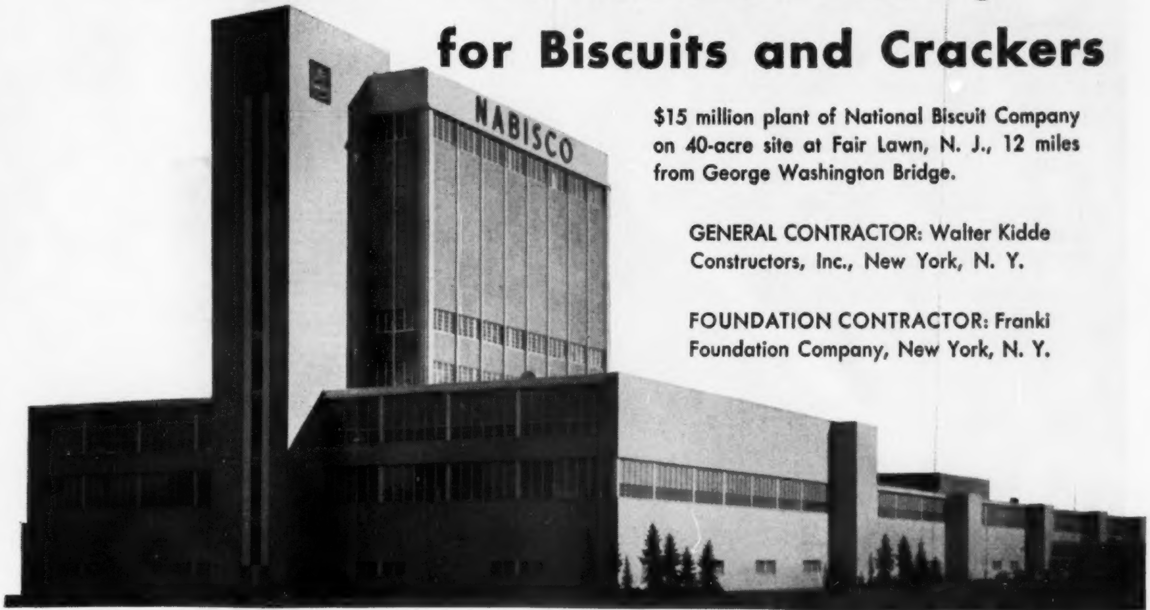


$15 million plant of National Biscuit Company on 40-acre site at Fair Lawn, N. J., 12 miles from George Washington Bridge.

GENERAL CONTRACTOR: Walter Kidde Constructors, Inc., New York, N. Y.

FOUNDATION CONTRACTOR: Franki Foundation Company, New York, N. Y.

164-Foot High Tower Section for Raw Materials Storage and also 2-Story Laboratory Built on Franki Displacement Caissons Bearing in Granular Subsoil.

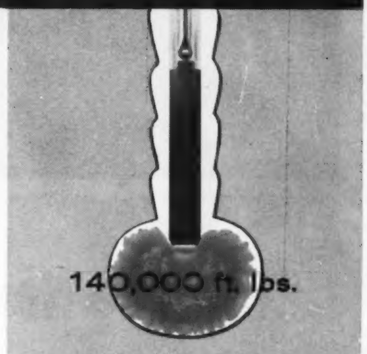
This newest of 10 Nabisco bakeries and a major unit in a $180 million expansion and modernization program was designed and its construction supervised by the Company's own engineering department.

When borings for the tower section at the north end of the plant showed granular subsoil, Nabisco engineers recognized that displacement caissons with expanded base footings would provide a solid and most economical foundation. The tower is primarily for storage of 75 carloads of raw materials with mixing departments in the lower area.

After Franki engineers completed additional soil tests, two rigs installed 407 Franki Displacement Caissons at depths averaging 20 feet below grade, at a rate of better than 6 per day per rig during 36 driving days of cold December and January weather. Groups of caissons carry column loads as high as 940 tons.

Later, Franki engineers were called in again, this time for the foundations for an adjoining two-story Research and Development Laboratory at the south end of the four-block long bakery. A single rig installed 130 Franki Displacement Caissons in 20 driving days at average driven depths of 21 feet.

These two Nabisco installations, like other Franki work, were quoted on a lump sum basis without qualification or payment for excess footage. All work was guaranteed.



Advantages of Franki Methods

A Franki Displacement Caisson, with its surrounding compacted earth mass, exploits the maximum bearing capacity of the soil.

Every Franki pressure-injected-type footing of "dry"* concrete is "forged" with 140,000 foot-pound blows of a falling ram, a force many times greater than the blow of a steam or pneumatic hammer.

As a result, the advantages are:

1. High unit load capacity due to expanded base made in granular soil.
2. Economy because fewer Franki caissons of shorter length are required.
3. Volume of reinforced concrete caps is reduced to a minimum with corresponding savings in cap excavation, sheeting, reinforcing, forms and backfill.
4. Concreting of shaft can be made at any cutoff elevation below grade. Installation can be made in advance of general excavation with resulting saving in sheeting, bracing and maintenance. Depending on water table elevation, economies in pumping costs may also result.

*"Dry" concrete is defined as zero slump concrete using approximately 3½ gallons of water per bag of cement.

Consult Franki engineers on your foundation problems.

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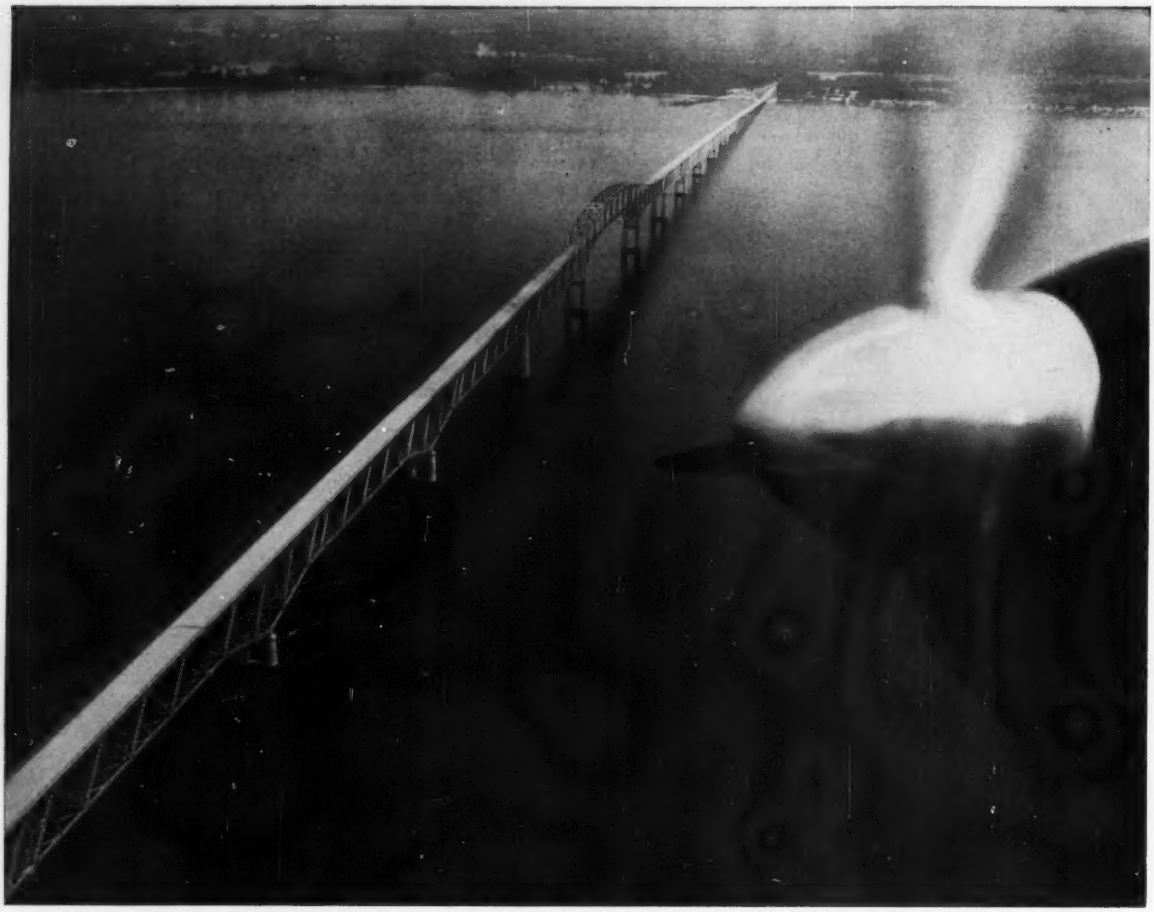


Another major bridge joins the growing list of bridges large and small built for lasting economy with bearing plates of Lukens stainless-clad steel.

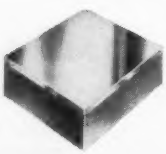
In The New Rappahannock River Bridge

LUKENS CLAD STEEL BEARING PLATES SAFEGUARD SOUND ENGINEERING

Bridge bearing plates of Lukens stainless-clad steel provide the corrosion protection of stainless—economically. Maintenance costs are reduced to a minimum. The free movement so essential to bridge safety is assured. In addition to the Rappahannock, other major bridges employing Lukens bearing plates include the Walt Whitman Bridge, the Greater New Orleans Mississippi River Bridge, and the Throgs Neck Bridge now being built.

To meet varying design demands, particularly with regard to strength, there are two types of Lukens clad steel bearing plates. The standard type provides a minimum yield strength of 30,000 psi. A higher strength plate—incorporating A-302, Grade B backing steel for use in larger bridges—will meet a 50,000 psi. minimum yield strength requirement. And all bearing plates can be supplied flattened and machined on both sides to within .010 inch of dead flat.

For details, write—Manager, Marketing Service, 164 Lukens Building, Lukens Steel Company, Coatesville, Pa. Ask for special bulletin 180.



LUKENS clad steel is a solid plate—one surface corrosion-resistant metal permanently bonded over all to an economical backing steel.

LUKENS

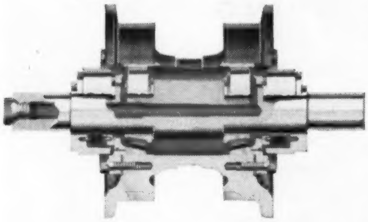
Why waste time greasing track on any of your tractors...

when you can have

Permanent Lubrication CERTIFIED

The Positive Seal
PERMA-SAFE
Wheel

for truck wheels, front idlers and support rollers on all models of Allis-Chalmers crawler tractors



Now...Allis-Chalmers announces PERMA-SAFE lubrication for all models in its crawler tractor line... climaxing more than 20 years of constant research and on-the-job experience with Positive Seal, tapered roller bearing design. Now you can forget about track-level greasing...convert that lost time to profit time. Allis-Chalmers, pioneer of extended lube intervals, lets you take this big step ahead with complete confidence.

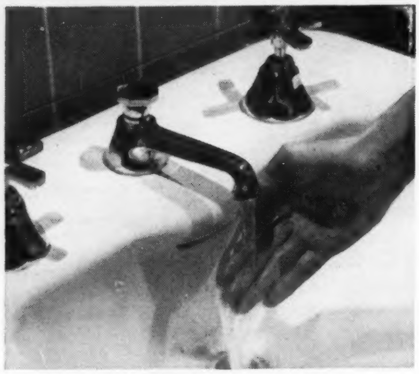
See your nearby Allis-Chalmers dealer for the full story now. Allis-Chalmers Construction Machinery Division, Milwaukee 1, Wisconsin.

move ahead with ALLIS-CHALMERS

...power for a growing world

BASIC...

WHEN WATER MEANT DRUDGERY! The water our ancestors used was as difficult to come by as it was doubtful in quality.



TODAY'S HOUSEKEEPER, served by a modern American water system, finds the water she needs—clean pure water—at her fingertips.

U.S. cast iron PIPE

FOR WATER, SEWERAGE AND

U. S. PIPE AND FOUNDRY COMPANY

but better than ever today!

Modern technology plus mine-to-line control insures top quality of U.S. Cast Iron Pipe

Our water today is made so universally pure and wholesome no American ever doubts its quality.

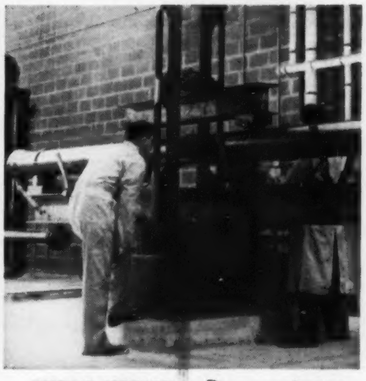
This is a tribute to the forward-looking water officials who plan and administer the nation's water systems... and their suppliers.

For example, U. S. Pipe controls every step from mining to shipping ... uses every possible quality check to make sure its product measures up to the heavy responsibility placed on it.

This close and painstaking supervision insures the unvarying high quality and dependability of U. S. Pipe—both indispensable to a product that plays so big a part in protecting the nation's health.

GOOD PIPE BEGINS HERE... At one of U. S. Pipe's mines near Birmingham, where high grade coking coal, essential to quality, is mined.

PIPE TAKES SHAPE... Molten iron in this rapidly rotating mold assumes its form as pipe—one of many manufacturing steps.



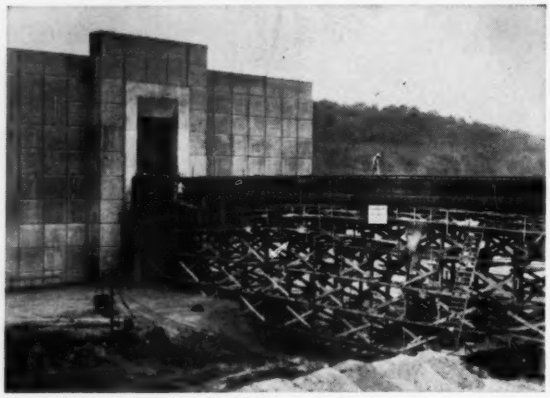
TESTING STRENGTH... Pipe specimens are periodically subjected to more brutal treatment in laboratory than they will receive in normal service.

INDUSTRIAL SERVICE CAST IRON ®

Birmingham 2, Ala. *A wholly integrated producer from mines and blast furnaces to finished pipe.*

LONGEST PRESTRESSED CONCRETE SPAN IN U.S.–

BUILT WITH LEHIGH CEMENT



An extensive false-work system carried formwork for this record *single span* hollow box girder. Huge 700-ton concrete counterweights, which balance the dead load of the bridge, are housed in the two station buildings.

Engineers: Corps of Engineers, U. S. Army, Washington District

Architects-Engineers: Black and Veatch, Kansas City, Mo.

General Contractor: James McHugh Construction Co., Chicago, Ill.

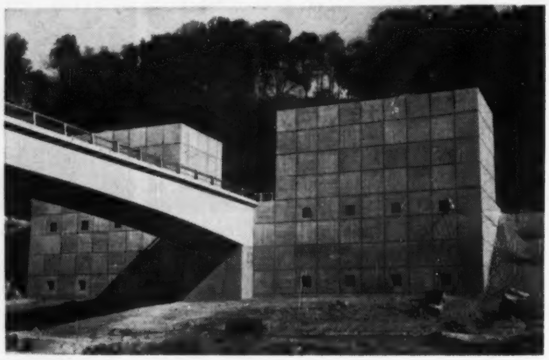
Sub-Contractor For Prestressing: Prestressing, Incorporated, San Antonio, Texas

This beautiful *single span* bridge is only 7′ deep at center and 12′ deep at the ends. The roadway on the bridge is 16′ wide. Future plans call for a dual-lane highway running along the C. & O. canal.

• Arching 216′ across the C. & O. canal paralleling the Potomac River at Little Falls, Md., this cast-in-place, post-tensioned Washington Aqueduct bridge joins a riverside pumping station with an electrical sub-station and forms part of the new $6 million water supply project for Washington, D. C.

With Lehigh Cement used throughout, the prestressed concrete span supplants the 160′ center span of the Walnut Lane Bridge in Philadelphia (another "all-Lehigh Cement" project) as the longest in the country.

Once again, in a record-breaking job demanding the best in men and materials, Lehigh Cement has proved its value.



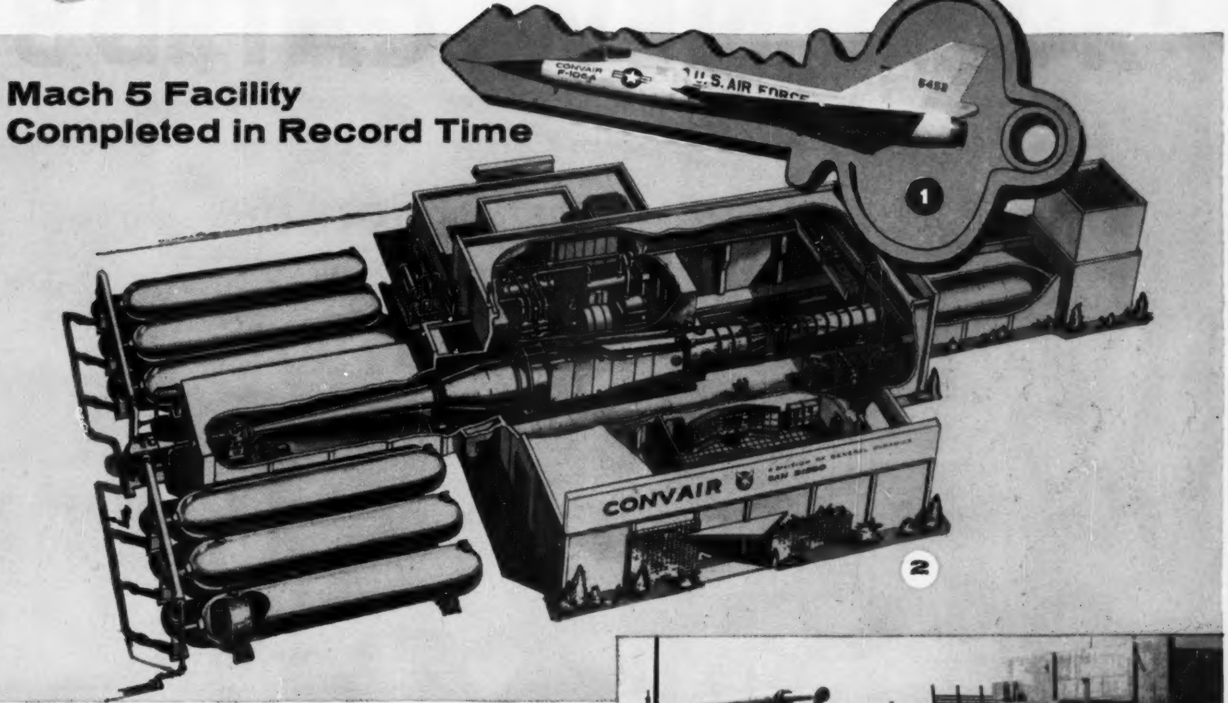
Note attractive architectural treatment of concrete surfaces of the sub-station. Over 60,000 barrels of Lehigh Cement were used in the entire project which includes the bridge, buildings, a dam and an outlet tunnel.

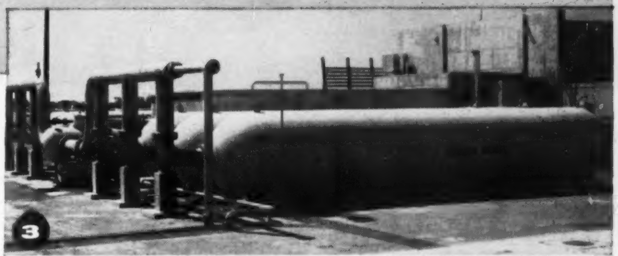
LEHIGH PORTLAND CEMENT COMPANY

ALLENTOWN, PA.

CB&I turns the key on construction of Convair Supersonic Wind Tunnel

Mach 5 Facility Completed in Record Time





CB&I specialists, working in cooperation with *Flui Dyne* Engineering Corporation, handled the engineering, fabrication and assembly of this country's first "turn-key" supersonic wind tunnel. Built for Convair Division of General Dynamics Corporation, the intermittent *blow-down* type tunnel is capable of simulating speeds that range from Mach 0.5 to 5 (five times the speed of sound).

This $3,500,000 project for Convair is one of several supersonic test facilities in which the coordinated facilities of CB&I are playing a major role. These same engineering, fabrication and erection services can provide *you* with the benefits of *one source craftsmanship in steel*—with which CB&I has served industry, science and government for almost seven decades. Write our nearest office for a copy of the *Convair Story*.

E62CB

1. **F-106 A Delta Dart,** supersonic all-weather interceptor being manufactured by Convair for the United States Air Force.

2. Sketch shows major components of CB&I-built 3,700 MPH wind tunnel at Convair plant, San Diego, California.

3. Six CB&I-built tanks store air at 600-psi for intermittent blow-down type tunnel.

4. Tunnel "throat" or nozzle is comprised of flexible plates to generate flow from Mach 1.6 to 5—was precision assembled to few thousandth of an inch accuracy.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
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CATERPILLAR'S
PROJECT
PAYDIRT

PROJECT PAYDIRT *pays off for you*

NEW CAT D8

PUSHLOADING: PRODUCTION UP

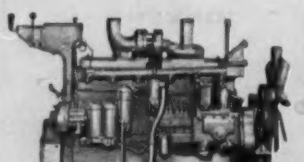
The new Caterpillar D8 Series H Tractor is ready *now* to increase its lead as undisputed king of its size class. A major achievement in Caterpillar's all-out research program, "Project Paydirt" (see box), the new D8 has been proved through a rigorous field testing program.

This D8 is new in design, appearance and performance. It is bigger, more powerful. It incorporates new engineering advances. It is easier to operate.

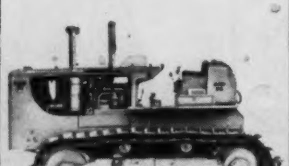
Now—what can it do for you? Here's the answer:

The D8 has been thoroughly field tested on actual jobs. Several of the big new tractors have been at work constantly in every kind of material. Out of the statistics developed, both pushloading and bulldozing production figures are *up*.

This means that you can move dirt faster and cheaper than ever before with a tractor in this size class. You



HORSEPOWER INCREASED 18%. The horsepower of the new D8 is up from 191 to 225 at the flywheel, from 155 to 180 at the drawbar. In addition, engine torque rise now is 20%, an increase of one-third. Over-all engine performance has been greatly improved by the addition of a turbocharger.

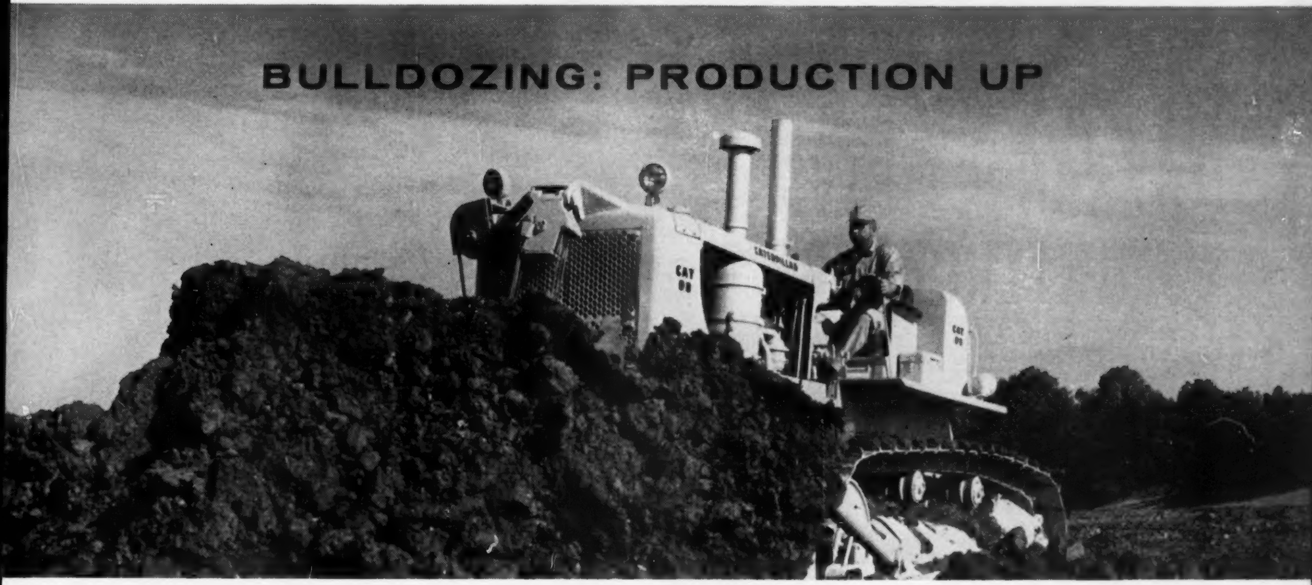


SIZE INCREASED. To make effective use of the new horsepower, over-all weight of the tractor has been increased 4,400 lb. to a total of 47,000 lb. At the same time the gauge has been increased to 84 inches, track on ground lengthened to 114 inches, square inches of contact increased to 5,505.

LIFETIME LUBRICATED ROLLERS AND IDLERS. That's right—lifetime! In a major research breakthrough, Caterpillar has achieved track and carrier rollers and idlers that never require further lubrication until rebuilding. And service life is hundreds of hours longer than with ordinary rollers.

NEW, STRONGER, HEAVIER UNDERCARRIAGE. Every component, such as frames, links, braces, pins, bushings, shoes, has been made stronger by the use of improved materials and heat treat processes to provide longer life. And ground clearance has been increased 50% to almost 20 inches.

SERIES H TRACTOR



get higher production, bigger profits—yet the new D8 is actually *more economical* to own and operate!

But find out for yourself. Get the full story from your Caterpillar Dealer, all the eye-opening facts and figures that can only be touched on briefly here. Then *see* this great new machine at work on your operation as soon as possible. You can't afford not to!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

BORN IN RESEARCH... TESTED IN THE FIELD

DRY-TYPE AIR CLEANER. Here's still another major Caterpillar research development on the new D8—the new dry-type cleaner which removes 99.8% of dirt in the intake air, even under severe operating conditions. The new cleaner can be serviced in 5 minutes, costs a good deal less to use.

SUPERIOR OPERATION. Operator visibility is excellent because of higher deck and changed seat position. Console-type controls make operator's job easier. And on torque converter models, standard foot-operated decelerator can override hand throttle—free operator's hands for other controls.

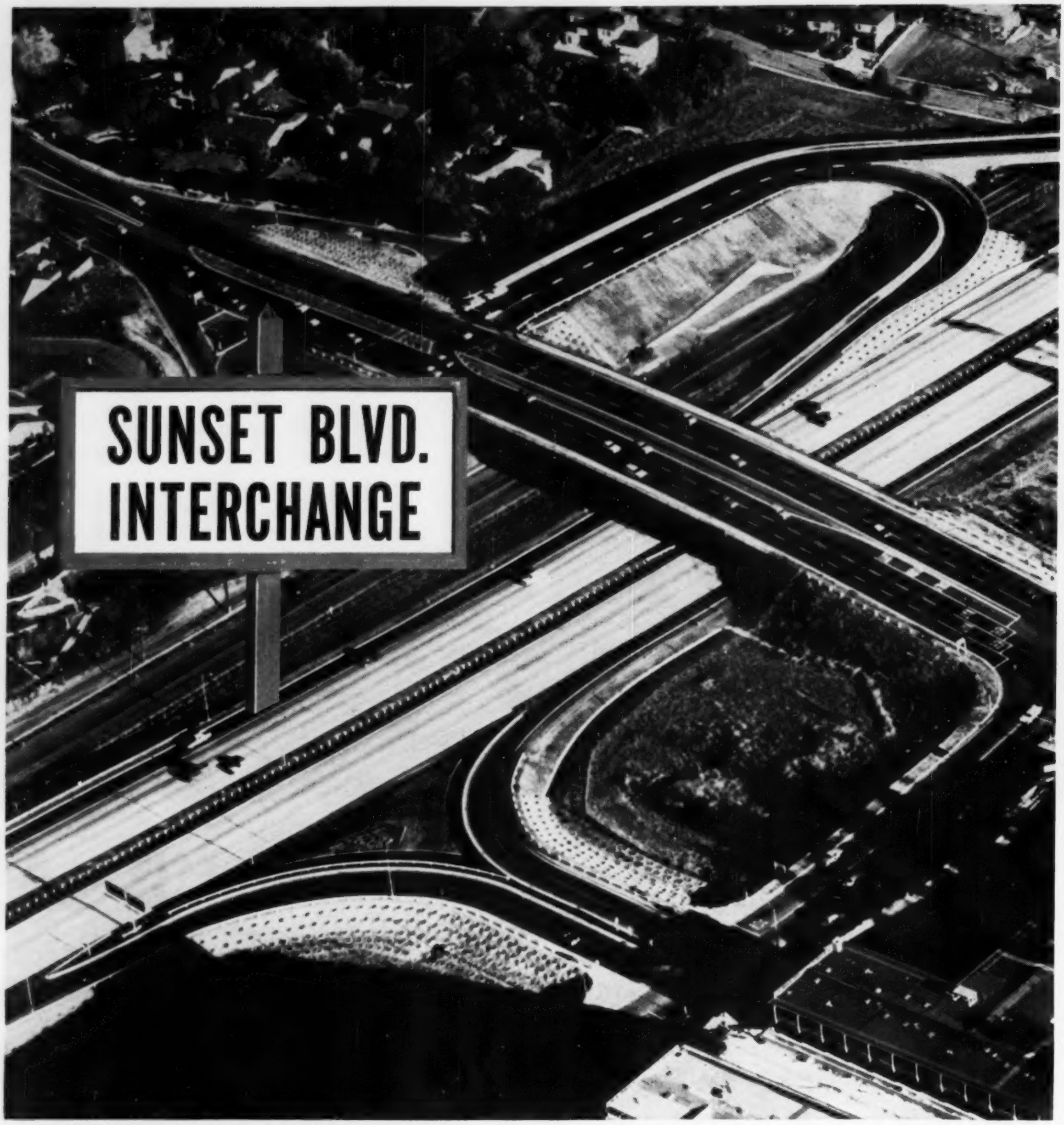
TWO MORE IMPORTANT OPERATOR CONVENIENCES

HIGHER SPEED. Completely new, long-life, direct drive transmission provides six speeds forward and six reverse. High speed has been increased to 6.3 MPH forward, 6.4 reverse to reduce cycle time. Operator can shift from any forward gear into a similar reverse gear (or vice versa) by simply moving the forward-reverse lever.

DEPENDABLE OIL CLUTCH. By contractor and operator demands, the virtually service-free, easy-to-operate oil clutch has been retained in the new D8. Another important Caterpillar exclusive.

CATERPILLAR'S PROJECT PAYDIRT

PROJECT PAYDIRT: Caterpillar's multi-million-dollar research program—to meet the coming challenge of the greatest construction era in history with the highest production earth-moving machines ever developed.



Photographs courtesy California Division of Highways

STAY ON SCHEDULE WITH *Reinforced Concrete*

Although the national roadbuilding program is in high gear, there are still many rivers to bridge . . . many freeway interchanges to build. Reinforced concrete is playing a major role in this vast construction undertaking. Reports from many important projects, such as the Sunset Boulevard Interchange on the San Diego Freeway in Los Angeles, indicate that more and more highway engineers find they can count on their bridge and separation structures being "completed on time" when they design for reinforced concrete.

Concrete Reinforcing Steel Institute

38 South Dearborn Street Chicago 3, Illinois

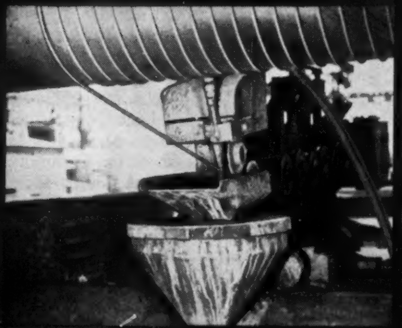
improving a superior product

American Concrete Cylinder Pipe has long been established as one of the outstanding developments in the field of pressure transmission of water. This superior design combines the physical properties of steel with the structural and protective properties of concrete — producing a pipe of great strength and long life. Important transmission lines of American Concrete Cylinder Pipe are today serving most of the major cities and population centers in the western United States.

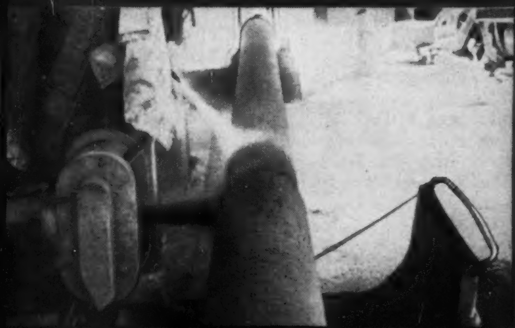
Through the years, continuing research has led to improved features in the manufacturing process. These features enrich the alkaline environment surrounding the steel components, which environment is so necessary to the continuing and everlasting protection that well-made concrete gives to this high quality pressure pipe.

Specify these plus-factors featured by American — where research, development and quality control are always striving to make high quality products even better.

American Concrete Cylinder Pipe is available in a diameter range of 18" through 60" I.D. and in standard lengths of 32 feet.



Rich cement wash [illegible] tensioning rod just before it is wound [illegible] measured tension and with [illegible] spacing [illegible] concrete lined cylinder provides positive assurance of a highly alkaline environment between surfaces of cylinder and circumferential reinforcement.



An additional rich cement wash over the entire outer surface of the pretensioned steel cylinder before application of the pipe's dense mortar coating assures maximum alkaline environment where it is most needed.

American

Los Angeles: 4635 Firestone Blvd., South Gate, Calif., LOrain 4-2511

Hayward: P.O. Box 630—JEfferson 7-2072

San Diego: P.O. Box 13—CYpress 6-6166

Phoenix: 2025 South 7th St.—ALpine 2-1413

Portland: 518 N.E. Columbia Blvd.—BUtler 5-2531

NEWS OF ENGINEERS

J. K. Gannett, a specialist in the industrial and commercial building field, retired January 1, after forty-three years with the Austin Company of Cleveland, Ohio, and fifteen as its vice president in charge of all engineering and research. Mr. Gannett is credited with many important "firsts." During World War II he established Austin's Special Devices Division to develop special electronic and optical devices for the U. S. Navy Bureau of Aeronautics, and more recently, he launched the company on a pioneer inquiry into the use of prestressed concrete beams in building construction.

J. K. Gannett

Theodore Leba, Jr., announces the removal of his office to 1710 Connecticut Avenue, N.W., Washington 9, D.C. Mr. Leba, who specializes in structural engineering, was formerly with the Washington branch of the National Concrete Masonry Association.

A. Warren Simonds is retiring as head of the Foundations and Structural Behavior Section of the Bureau of Reclamation in Denver, after more than 31 years of service. Internationally recognized as an authority on foundations and grouting and author of numerous technical papers in the field, Mr. Simonds has served as an engineering advisor to various foreign governments.

Merrill C. Lorenz is the newly appointed director of public works of Ventura County, Calif. Mr. Lorenz has been director of the Processes Division of the U. S. Naval Civil Engineering Laboratory at Port Hueneme, Calif., for the past eight years. For a number of years he had his own consulting and contracting firm in Iowa.

Henry J. Miles has joined the staff of the University of Arizona as professor of civil engineering in charge of hydraulics and fluid mechanics. Until recently Dr. Miles was supervising engineer with International Engineering Company, San Francisco, Calif. He has taught at the University of Florida, the University of Southern California, and the A. & M. College of Texas.

Charles G. Hoerner, who is retiring as division engineer for the Board of Water Supply of the City of New York, was guest of honor at a recent testimonial dinner at the Hotel Lenape, Liberty, N.Y. Mr. Hoerner began his professional career shortly after graduation from Cooper Union in 1909 and has served the City in various engineering capacities continuously since then. During that tenure his duties have been directly concerned with the construction of nearly all the large dams, tunnels, and appurtenant structures of the city's vast upstate water supply systems. He will continue to reside in Ellenville, N. Y.

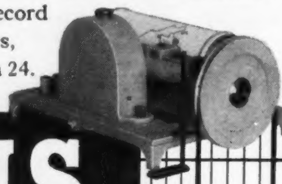
C. G. Hoerner

Robert Edmund Bald, former assistant chief engineer in the engineering department of the Lock Joint Pipe Company, of East Orange, N. J., has been named chief engineer of the Company. Mr. Bald joined the Lock Joint Pipe Company over ten years ago as a draftsman.

NOW
LOW-COST AUTOMATIC FLOW RECORDING

Directly Readable Flow Charts

Obtain graphic records of liquid flow directly readable in million gallons per day or gallons per minute over various sizes of Parshall flumes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams, wells. Write for free Bulletin 24.



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TYPE F RECORDER

...For Measuring Sewage, Industrial Waste and Other Flows

The planning and efficient operation of any project which involves measurements of flowing liquids is based on flow data which can be obtained with STEVENS Recorders. These instruments are at work compiling data on hydroelectric and flood control projects and in water works, sewage disposal plants, irrigation and industrial installations in all parts of the world.

Experienced technical staff available to supply product information for liquid measurement installations. Write, giving description of project and scope of data desired.

HYDROGRAPHIC DATA BOOK
invaluable for your reference file
124 pages of technical data on recorder installations, plus a wealth of hydraulic tables and conversion tables. $1 copy. (No COD's.

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specialists in hydrologic instruments for over half a century

Harold E. Hedger retired in January after twenty years as chief engineer of the Los Angeles County Flood Control District. During his tenure as chief engineer, Colonel Hedger supervised a flood control and water conservation program that has engendered international interest. In 1957 he served as a special consultant for the U. S. Government to the Ministry of Irrigation and Power of India. Colonel Hedger has been succeeded by Markham E. Salsbury, his senior aide for many years.

H. E. Hedger

Burdette K. Beebe has been made vice president and resident manager of Fay, Spofford & Thorndike, Inc., engineers of Boston, Mass., in an expansion of the firm's activities. Mr. Beebe, a director of the firm, will be in charge of its new offices at Phoenix, Ariz. The new office will serve the western United States, Mexico, and Central America on engineering for military facilities, airports, express highways, bridges, industrial plants, port and terminal works, power plants, water supply and sewerage, drainage, and incinerators.

Edwards and Kelcey, engineers and consultants, announce that the following members of their Newark, N. J., and Boston, Mass., offices have been admitted as associates: **Wesley La Baugh,** highway engineer; **William J. Mulder, Jr.,** assistant to the chief engineer; **Norman Charles Possiel,** office engineer; **Nicholas M. Setteducato,** project engineer; and **Warren Travers,** junior engineer.

Vincent J. Vitagliano, assistant professor of civil engineering at Manhattan College, Riverdale, N. Y., has been awarded a $4,600 plus tuition Science-Faculty Fellowship by the National Science Foundation. The award will allow Professor Vitagliano to complete his studies for a doctorate in civil engineering at New York University. A graduate of Manhattan College with a master of science degree from Virginia Polytechnic Institute, he has been a member of Manhattan's faculty for five years.

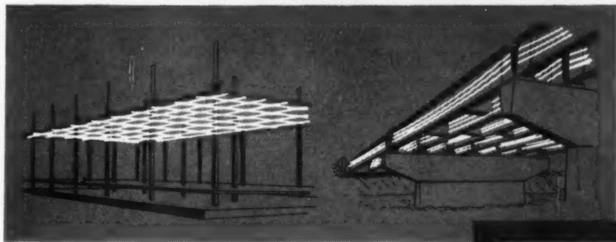
Lester A. Robb has accepted an appointment as water resources planning engineer with the International Cooperation Administration in Phnom Penh, Cambodia. Mr. Robb, formerly with the U. S. Bureau of Reclamation, has previously served with the ICA in Beirut, Lebanon. For the past two years he has been in charge of the Bureau's Hydrology and Flood Control Branch in Carson City, Nev.

L. A. Robb

William H. Mitchell has transferred from his position as chief construction management engineer with the USAF Installations representative, New England Region, to the new position as chief regional engineer with the U. S. Post Office Department, Boston, Mass. He will have responsibility for the engineering program which includes research, construction, management analysis, mechanization and automation of postal installations and technical guidance on manpower utilization in the New England Region. Mr. Mitchell is chairman of the Society's 1960 Annual Convention to be held in Boston.

George Allen Young, associate professor of civil engineering at the University of Illinois, has accepted a position as chief of the Civil Engineering Section, Air Force Ballistic Missile Division, at Ingleside, Calif. Professor Young will serve as the chief consulting civil and architectural engineer of a developmental group that will provide the design criteria for private consulting engineering firms to follow, will recommend the private consulting firms to do the designs, and will finally approve the designs prepared by them.

(Continued on page 22)



Tomorrow's patterns for gracefully functional structures, combining great strength with a minimum of mass, are taking shape today throughout the world.

Their design and construction characteristics are made possible, in large part, through widespread developments in concrete prestressing techniques and methods.

The Prescon System of post-tensioning is proving its worth in buildings, bridges, reservoirs and in many other structures employing prestressed concrete.

FOR THE CONTRACTOR it means tendons delivered to the job site, completely assembled, clearly identified and ready for the forms; a Prescon representative to instruct his men in placing and stressing the tendons, using stressing equipment—provided by Prescon.

FOR THE ARCHITECT AND CONSULTING ENGINEER it means assistance with design and engineering when needed; and assurance that Prescon can be specified with confidence.

FOR THE OWNER it means graceful, functional construction with maximum space utilization, and long spans with minimum material usage.

Write for new folder giving complete, detailed information including examples of structures using The Prescon System.

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General Offices and Southwestern Division:

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DRake 7-3853	P. O. Box 38	SUnset 1-4706	FAculty 1-3577
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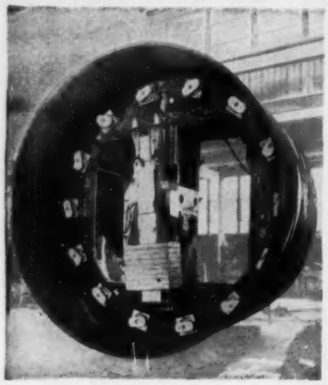
MEMBER PRESTRESSED CONCRETE INSTITUTE

MAYO SANDHOG EQUIPMENT



Design and construction of Mayo Shields and other Sandhog Equipment are backed by over 25 years of job-tested experience throughout the world.
FREE BULLETIN No. 28 shows installations of Mayo shields, cylindrical air locks, lock doors, medical locks and tunnel cars. Send for your free copy today.

SPECIAL EQUIPMENT DEVELOPED FOR SPECIAL PROBLEMS

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NEWS OF ENGINEERS

(Continued from page 21)

Mason G. Lockwood, Past-President of ASCE, has been elected president of the Houston Chamber of Commerce for 1959. Mr. Lockwood, a partner in the Houston consulting engineering firm of Lockwood, Andrews & Newnam, was honored at a luncheon meeting of the 1959 directors in the Houston Club preceding the 118th annual meeting of the Chamber.

Jack R. Barnes, engineer-geologist, announces a change of address for the J. R. Barnes Engineering Company. The new offices are located at 9115 Barnet Road, Austin, Tex., while the new mailing address is Box 9222, Austin 17, Tex.

Lewis A. Young has been appointed secretary-manager of the Southern Clay Pipe Institute at its new offices at 1401 Peachtree Street, N. E. Atlanta, Ga. The Institute plans to expand its programs to include educational, experimental, and research activities. Mr. Lewis was formerly officer-in-charge of the U. S. Public Health Service's Southeast Drainage Basins Office in Atlanta. He has recently been elected vice president of the ASCE's Georgia Section.

Lewis A. Young

James H. Le Van has been relieved from duty as sanitary engineer director for the Health Research Facilities Branch, National Institutes of Health, U. S. Public Health Service, and detailed to the U. S. Coast Guard as chief sanitary engineer officer with headquarters in Washington, D. C.

Harold A. Fidler, former manager of the Atomic Energy Commission's San Francisco Operations Office at Oakland, Calif., has been appointed assistant to the director of the Ernest O. Lawrence Radiation Laboratory, University of California, Berkeley. Dr. Fidler's association with the U. S. atomic energy program began in 1942 when he was given responsibility for the initial phases of research and development on the atomic bomb at the University of California.

Cecil H. Wells, Jr., consulting structural design engineer, has opened new offices at 2006 Pioneer Court, San Mateo, Calif. Mr. Wells lectures on structural engineering at Stanford University and Menlo College in California. He is also active in civic affairs as chairman of the San Mateo Planning Commission and vice president of the Tri-County Planning Council which serves San Francisco, San Mateo, and Santa Clara.

C. H. Wells, Jr.

James M. Hastings was recently made a partner in the consulting firm of Ketchum & Konkel, of Denver, Colo. The name of the firm will be changed to Ketchum, Konkel & Hastings. Mr. Hastings, who has been an associate in the firm since 1955, is a Lieutenant Commander in the Civil Engineer Corps of the Naval Reserve. Before joining Ketchum & Konkel he was structural engineer with Stearns-Roger Manufacturing Company, at Denver, for several years.

James Hastings

Leo Louis, Jr., vice president and general manager of the Gary-Hobart Corporation, of Gary, Ind., has been appointed to the National Defense Executive Reserve of the U. S. Department of Commerce's Business and Defense Services Administration. In this capacity Mr. Louis will be called on to staff the operation of an emergency production agency both at regional and national headquarters in event of hostilities involving this country.

Walter Schielke, former assistant to the vice president of the American Bridge Division, of U. S. Steel, at Houston, Tex., was recently made Southern area regional manager. Mr. Schielke will continue in the company's Houston offices.

Wright Hiatt, retired Colonel, Corps of Engineers, is a recent appointee to the post of managing engineer for the Atlantic-Gulf Division of the Asphalt Institute, with headquarters in College Park, Md. He will direct the Institute's engineering activities in twenty coastal and southern states, ranging from Maine to Louisiana. Colonel Hiatt joins the Asphalt Institute's field engineering staff from the New York consulting firm of Tippetts - Abbett - McCarthy - Stratton, where he has served as project engineer since his retirement from the military service in 1957.

Wright Hiatt

Whitney C. Huntington and **Nathan W. Dougherty,** Honorary Members of ASCE, are members of a team of experts in engineering teaching named by the American Society for Engineering Education to study plans for a new engineering school at Kanpur, India. The team is touring India for six weeks at the request of the Indian Ministry of Scientific Research and Cultural Affairs and the U. S. International Cooperation Administration. They are visiting existing universities, colleges, and industrial plants in an attempt to evaluate tentative plans for the proposed new institute. Professor Huntington is pro-

fessor emeritus of civil engineering at the University of Illinois, and Professor Dougherty recently retired as dean of the College of Engineering at the University of Tennessee. Dean Dougherty is deputy director of the mission.

Charles I. Mansur has joined Luhr Bros., Inc., of Columbia, Ill., as chief engineer. Mr. Mansur was most recently vice president and chief engineer with the Independent Wellpoint Corporation of Baton Rouge, La.

Andrew C. Paton is a new partner in the firm of Metcalf & Eddy, engineers of Boston, Mass. In 1942 he joined Metcalf & Eddy as senior engineer on air base projects in North and South Carolina, leaving for wartime service as a lieutenant in the 84th Naval Construction Battalion serving in the Southwest Pacific. In 1951 he rejoined Metcalf & Eddy, where he has recently been director of operations in the Boston Office.

A. C. Paton

James H. Jiranek has been assigned as a sales representative to the Allentown, Pa., district of Allis-Chalmers Industries Group. A civil engineering graduate of Princeton University, Mr. Jiranek recently completed Allis-Chalmers' training course for graduate engineers.

David M. Greer, consulting soils and foundation engineer, and President of Greer Engineering Associates, Inc., of Montclair, N. J., announces the merger of his business with that of Woodward, Clyde, Sherard, and Associates of Oakland and San Diego, Calif.; Denver, Colo.; Kansas City, Mo.; and Omaha, Nebr. Mr. Greer will continue in charge of the Montclair office, which will operate under the name of Greer Engineering Associates, Inc., a Division of Woodward, Clyde, Sherard, and Associates.

David M. Greer

Charles M. Noble has resigned as Ohio director of highways to return to his home in Princeton, N. J. He will undertake consulting work on an advisory basis. Mr. Noble was chief engineer of the New Jersey Turnpike Authority at the time of his appointment to the Ohio highway post in January 1957.

Stanley E. Sporseen is joining North Pacific Consultants, a Portland, Ore. and Anchorage, Alaska, engineering firm, in a key position. He is one of the first appointees in an expansion program the firm has initiated. Mr. Sporseen was formerly head of the Project Planning Section of the Portland district of the Corps of Engineers.

(Continued on page 116)

Voids Reduce Weight and Maintain Rigidity in Warped Slab

Garage ramp of Pacific Telephone & Telegraph office, Oakland, Calif. Ira Beals, architect; Pregnoff and Mather, engineers; R. F. Royden, contractor.

Form voids in concrete slabs with low-cost SONOCO SONOVOID FIBRE TUBES

Weight became a problem in the design of this concrete garage ramp. To provide required structural rigidity, the warped slab had to be extra thick in depth . . . extra weight was reduced by planning a voided slab system.

Using low-cost 12" O.D. SONOVOID Fibre Tubes to form voids, the dead weight of low-working concrete was eliminated, with slab strength and rigidity maintained.

SONOVOID Fibre Tubes are specifically designed for use in bridge decks, floor and roof slabs, and in concrete piles. For precast, prestressed units or members cast in place. The voided slab system means savings in concrete and reinforcing steel.

Sonoco Fibre Tubes are available in sizes from 2.25" to 36.9" O.D. Order in specified lengths or standard 18' lengths. Can be sawed to your requirements on the job. End closures available.

Write for complete technical information and prices.
See our catalog in Sweet's

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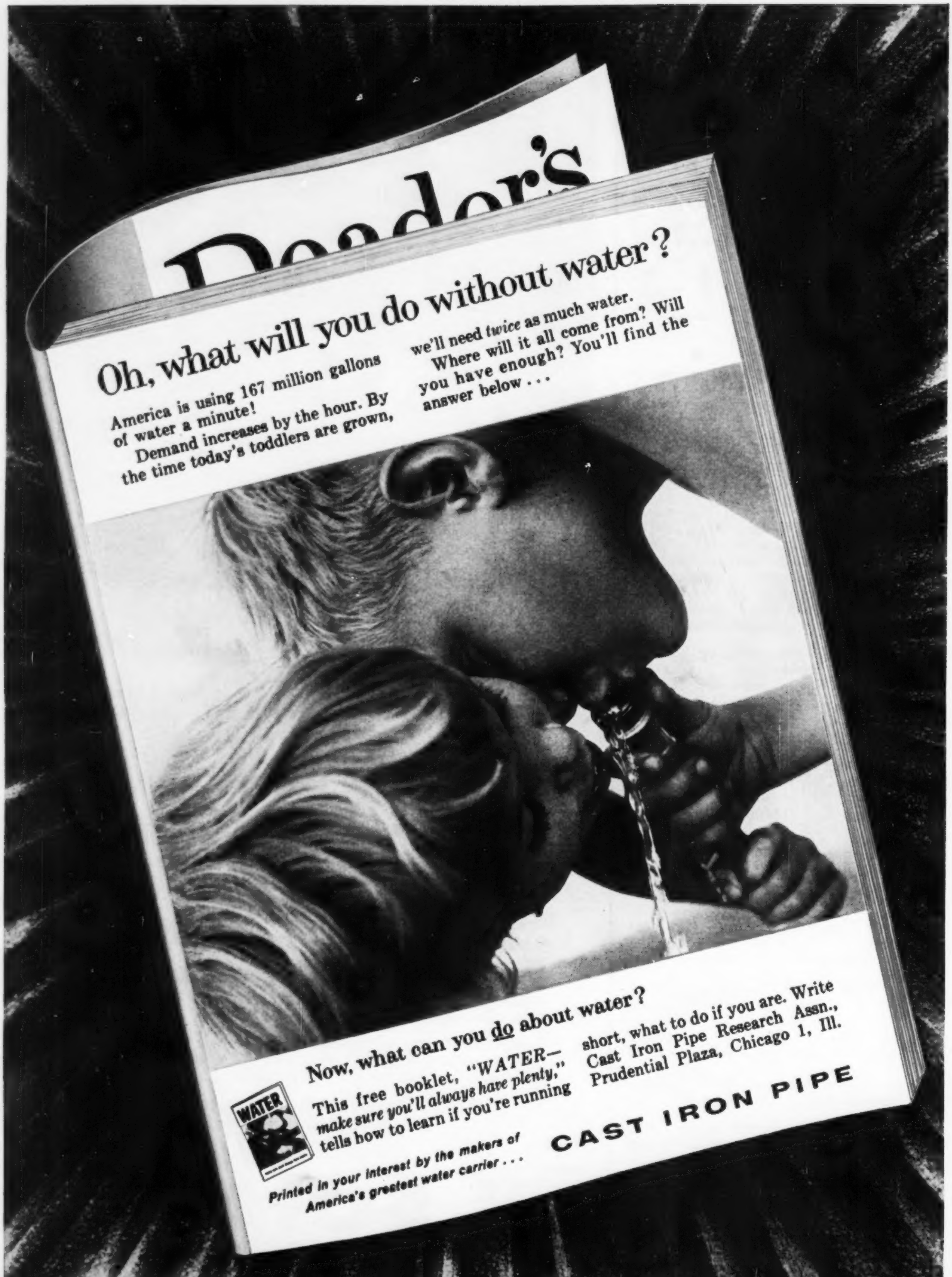

Reader's
Oh, what will you do without water?
America is using 167 million gallons of water a minute!
Demand increases by the hour. By the time today's toddlers are grown, we'll need *twice* as much water.
Where will it all come from? Will you have enough? You'll find the answer below . . .
Now, what can you do about water?
This free booklet, "*WATER— make sure you'll always have plenty,*" tells how to learn if you're running short, what to do if you are. Write Cast Iron Pipe Research Assn., Prudential Plaza, Chicago 1, Ill.
WATER
CAST IRON PIPE
Printed in your interest by the makers of America's greatest water carrier . . .

New Ad Campaign in Reader's Digest Dramatizes America's Water Problem

Cast Iron Pipe Research Association promotes better understanding of water supply and distribution problems

Offers Informative Booklet for Step-by-Step Action at the Local Level

Here's help for consulting engineers and everyone else directly concerned with the supply, treatment and distribution of water—help that will acquaint the general public and community leaders with the vital importance of this growing problem.

On the opposite page you see the first in a series of advertisements, this one appearing in February *Reader's Digest*. Placed by the Cast Iron Pipe Research Association, these striking advertisements point out to Mr. and Mrs. America how much we depend on a good water system and why we can no longer take it for granted.

Similar advertising will appear regularly this year in *U. S. News & World Report*, *Nation's Business*, *Better Homes & Gardens*, *American Home* and *Sunset* magazines to carry this public service message to millions of community leaders and homeowners.

Free Local Plan-of-Action Booklet

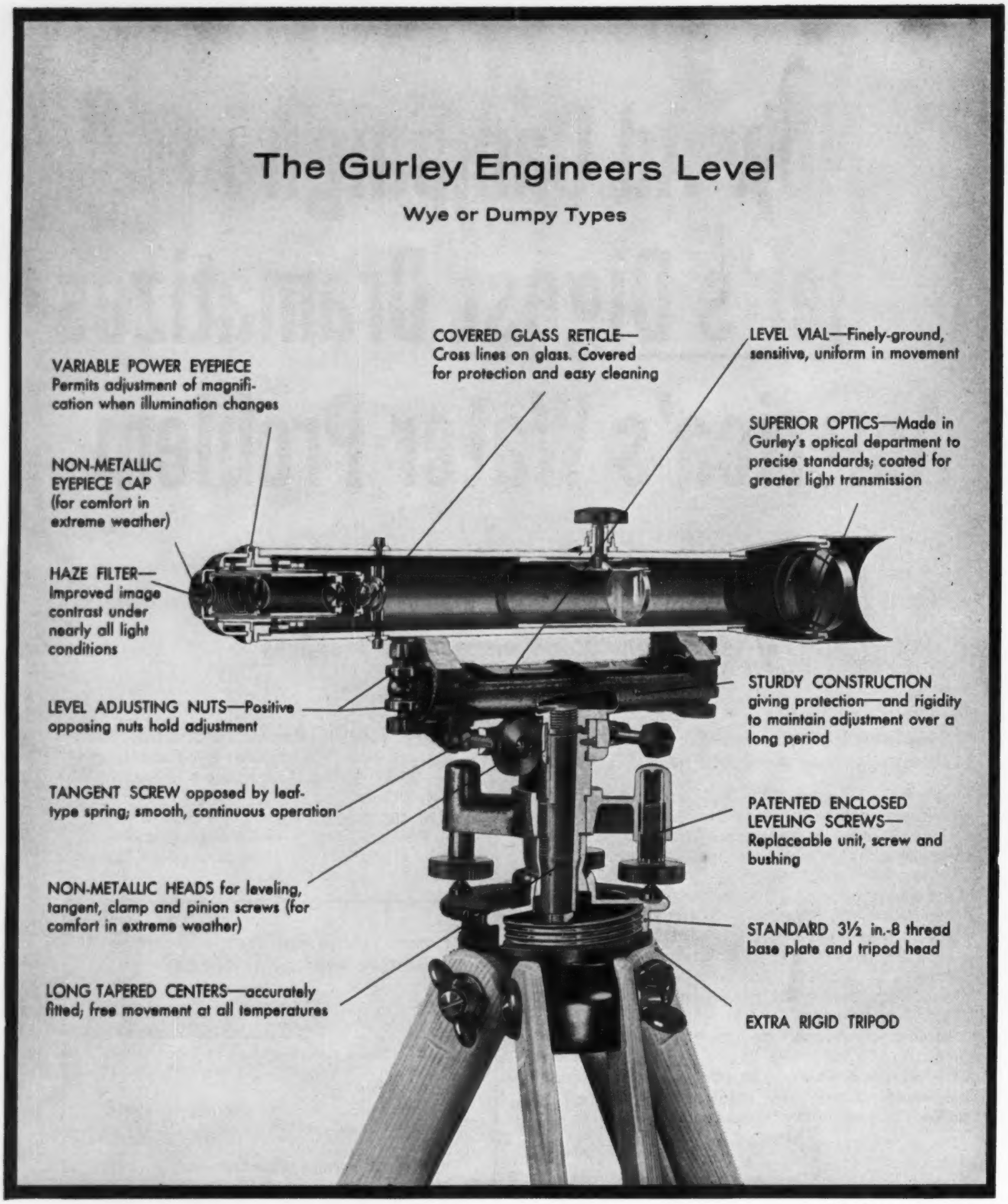
These ads offer a free booklet telling about the water problem. It shows how responsible citizens can acquaint themselves with the needs of their community. It also gives a step-by-step outline of action, telling how they can help their officials extend and improve the local water system through more adequate rate structures or financing.

We'll be happy to send you a free copy of this new booklet. Write to Thos. F. Wolfe, Managing Director, Cast Iron Pipe Research Association, 3440 Prudential Plaza, Chicago 1, Ill.

THREE REASONS WHY* CAST IRON PIPE IS *AMERICA'S GREATEST WATER CARRIER:

1. More miles of underground cast iron water mains are now in use than of all other kinds of pipe combined.
2. More miles of cast iron water mains are now being purchased and laid than of any other kind of pipe.
3. Impartial surveys prove that today's water utility officials and consulting engineers prefer cast iron pipe for underground water distribution by an overwhelming majority.

CAST IRON PIPE



Model 372 Dumpy Level

GURLEY

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I want a new plant building.

I want it fast.

I want it strong and tough.

I want few columns, more open areas.

I want a building that's easy to expand.

I want to keep the initial cost low.

I want to keep maintenance costs low, too.

Now, what structural material do you recommend?

Give the man what he wants: Recommend framing his plant building with structural steel. Only steel framing meets all his demands. Both steel producers and steel fabricators have expanded facilities. There's an ample supply of the fabricated structural shapes you need--when you need them.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

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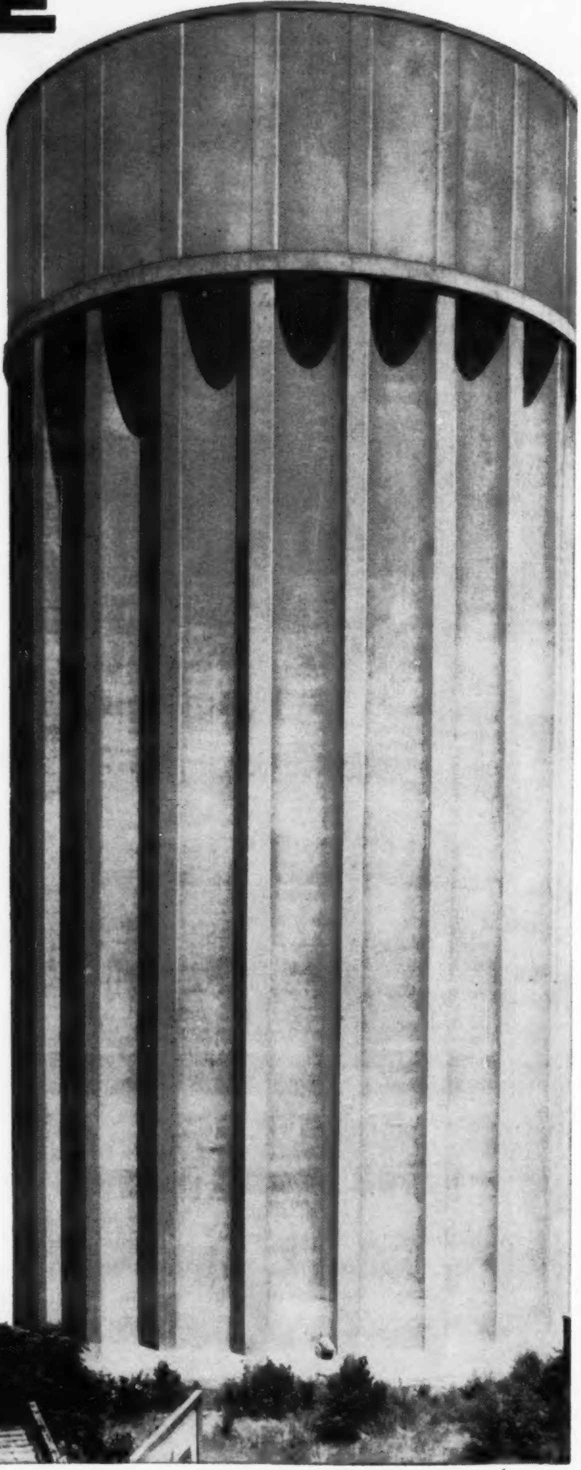

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. . . . . Am-Soc Briefs

▶ ▶ Honor roll . . . It is unofficially reported that two more Sections — Philadelphia and Hawaii — have gone over the top in the ASCE Member Gifts campaign for the United Engineering Center. The other five on the honor roll are, in the order of meeting their quotas, Kentucky, Lehigh Valley (with 115 percent), Nashville, Cincinnati, and Columbia. . . . As of January 16, ASCE had pledges promising $333,540 (or 42 percent) of its assigned $800,000 goal. With only 4,624 members subscribing, there are many still to be heard from.

▶ ▶ ASCE's attitude toward collective bargaining. . . . In response to requests for a statement of the official ASCE attitude toward labor unions for professionals, there is an article restating the Society's stand (page 75). In its twenty years of constructive interest in problems of unionization and collective bargaining, ASCE's sole desire has been to enable engineers to avoid inclusion in unions of non-professional employees and to permit them free choice of action. . . . Incidentally, two recent Supreme Court decisions affecting consulting engineers are reported by our Washington correspondent (page 84).

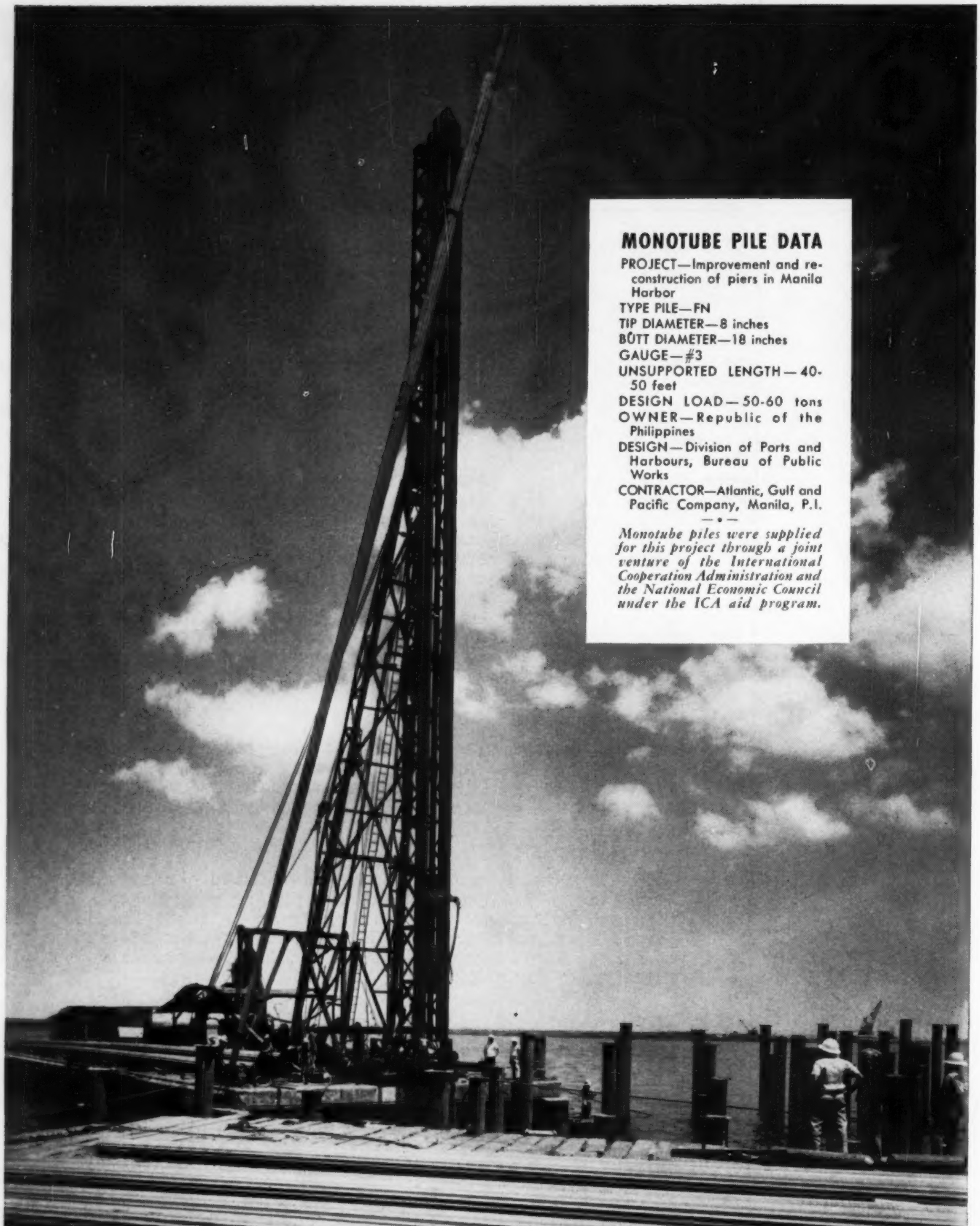
▶ ▶ In fiscal 1958 the Society had an unprecedented 41,377 members — an increase of 1,354 over 1957 and a giant leap from the ten-year-ago enrollment of about 26,000 at the end of 1949. . . . In 1958 the Technical Division Journals published 446 papers, an increase of 129 over the previous year.

▶ ▶ ASCE had a hand in the preparation of two new American Standards — Methods of Determining Areas in School Buildings and Methods of Determining Areas in Public Buildings. Irvine P. Gould was the ASCE representative on Sectional Committee Z65 of the American Standards Association, which formulated the standards.

▶ ▶ To one who has been foiled in trying to obtain career guidance literature for one of the major engineering branches, the ASCE list of guides available is particularly impressive: "You Can Be a Civil Engineer," "Your Career in Civil Engineering," "Civil Engineering — A Career," "After High School — What?", and "Brief Bibliography on Engineering as a Career."

▶ ▶ For sale. . . . The twenty-five papers presented at the popular Kansas City Conference on Electronic Computation are being offered, exactly as delivered, in a paper-bound photo-offset volume. The price will be $5 to members and $10 to non-members. For convenience in ordering a coupon has been provided in the advertising section (page 127).

▶ ▶ For free. . . . Every member is entitled to a free copy of the 1958 Index to Civil Engineering, which is ready now. Please inform the Executive Secretary (preferably by post card) if you wish to have a copy.



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It will soon be practical to drive from the United States to the Panama Canal? By the end of 1960, the International Road Federation thinks, judging from the impressive gains made in the Pan American Highway System in 1958. With the highway completed in the difficult Tapon area of northern Guatemala, there is now through travel between Mexico and San Isidro, Costa Rica. Work is being pushed on the two remaining sections—a 103-mile gap between San Isidro and the Panama border and a 35-mile stretch on the Panama side of the Costa Rican border. The I.R.F. estimates that the Pan American Highway now embraces about 19,000 miles (7,800 of them paved), covering areas from Alaska to Argentina and Chile.

▪ ▪ ▪

Today's hotly disputed Capitol enlargement project is not the first? Ever since construction of the Capitol began in 1793, there have been studies to see how the famous structure could be enlarged without sacrificing its appearance. Exactly a hundred years ago, in 1859, the South Wing had been completed for the House of Representatives and the North Wing was nearing completion for the Senate. Construction of the dome was just starting. The present $4,000,000 enlargement project, which will move the historic facade 32½ ft, will provide more office space.

▪ ▪ ▪

Canada set a new record in 1958 for installation of hydroelectric generating capacity? A total of 2,485,040 hp of new capacity was brought into service. In 1954, the previous peak year, 1,758,450 hp of new capacity was completed. Ontario, with a total of 1,301,800 hp of new capacity (most of it from the St. Lawrence Power project), was the province contributing most to the 1958 record installation; Quebec was next with 900,000 hp.

▪ ▪ ▪

Smog control in Southern California suffered a setback in 1958? Though a million and a half backyard incinerators were eliminated last year and $70,000,000 was spent on control devices, the smog was worse than in any year since 1955. The pessimistic report comes from A. J. Haagen-Smit, professor of bio-organic chemistry at the California Institute of Technology and consultant to the Los Angeles County Air Pollution Control District. Dr. Haagen-Smit attributes the situation to the unusually high temperatures, with heavy loss of gasoline from carburetors and automobile gas-tank vents. During hot weather these evaporation losses are said to reach 40 tons an hour in the Los Angeles area. New studies of gasoline are underway.

In 1957, some 11,130 U. S. communities had sewer systems serving 98.4 million persons? This was slightly over 57 percent of the total estimated population. Of the sewered population, 22.3 percent discharged raw sewage and 77.7 percent treated sewage. These facts are released in a "Statistical Summary of Sewage Works in the United States," issued by the U. S. Department of Health, Education and Welfare and available from the Government Printing Office (Washington 25, D. C.) at 20 cents a copy.

▪ ▪ ▪

Japan is pushing a dam-building program? With forty-two multi-purpose dams either completed or nearing completion, the Japanese government plans for sixteen more to cost about $200,000,000. Construction will start this year.

▪ ▪ ▪

Six types of atomic reactors are operating in sizes large enough to demonstrate their power possibilities? They are (1) Pressurized Water, up to 2,000-psf pressure, (2) Boiling water, (3) Sodium Graphite, (4) Breeder, (5) Organic Moderator, and (6) Homogeneous. For this information, our thanks to the January issue of Purdue University's "Sanitary Engineering News."

▪ ▪ ▪

Steel capacity is now at a record 147.6 million tons? The nation's steelmaking capacity increased nearly 7 million tons in the past year—to a record 147,633, 670 tons annually, as of January 1—according to the American Iron and Steel Institute. The new capacity is 61 percent higher than the potential at the end of the war and over 30 million tons above the industry's greatest annual production (117 million tons in 1955). Much of the increase in 1958 is attributed to the installation of new oxygen furnaces in several steel plants.

▪ ▪ ▪

The 1959 Nuclear Congress is set for Cleveland? the dates are April 5-10, and the place the Cleveland Public Auditorium. Engineers Joint Council is coordinating the congress for the thirty participating societies (ASCE among them, of course). The Congress will include the Fifth Nuclear Engineering and Science Conference, the Seventh Atomic Energy Management Conference, the Seventh Hot Laboratories Conference, and an "Atomfair." Congress manager is T. A. Marshall, Jr. c/o Engineers Joint Council, 29 West 39th Street, New York 18, N. Y.

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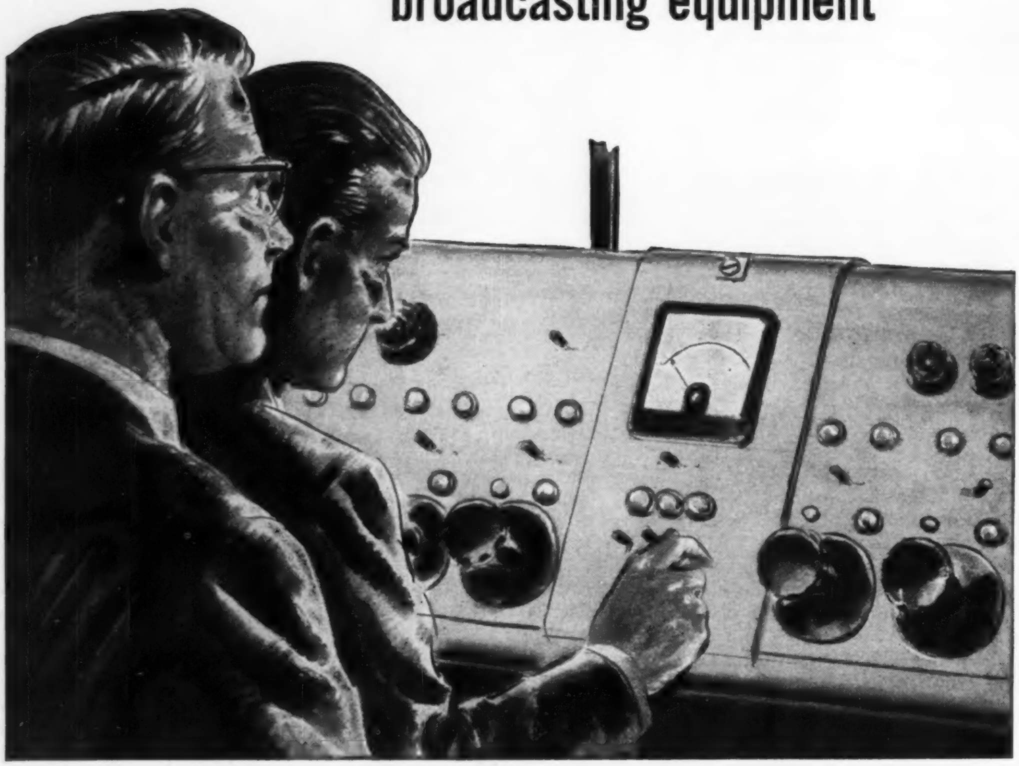

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CIVIL ENGINEERING

SOIL MECHANICS in action

KARL TERZAGHI, Hon. M. ASCE, Professor of Civil Engineering Emeritus, Harvard University, Cambridge, Mass.

The phrase "soil mechanics in action" is here applied to the use of soil mechanics as a tool in engineering practice. Some tools, like the slide rule, can be expertly used after reading the instructions; others, like the apparatus for geophyiscal subsoil exploration, can be used with tolerable confidence only after many years of experimentation. Soil mechanics belongs very definitely in the second category. The writer has never failed to point out in the prefaces to his books on soil mechanics that their contents should be used only as guides for judgment. They cannot be utilized successfully unless and until the reader has acquired a capacity for judgment, and this capacity can be gained only by years of contact with field conditions. Unfortunately it is a widespread habit among the readers of books to skip the preface.

Consider a college graduate who has passed his course in soil mechanics and absorbed the contents of his textbooks. Since such graduates are in great demand, he may be hired fresh from school by an employer who considers him an expert. The activities of such "experts" have led to what was recently described as the "crisis in soil mechanics." (Henry Lossier, "La crise de confiance de la mecanique du sol," *Le Genie Civil,* July 1958.)

If our graduate starts his career on a large job, eager to practice the principles he has learned, he is likely to find the essential facts concealed beneath a thick deposit of tables, graphs and cryptic memoranda resembling a tropical jungle. Such deposits are found on all large projects because such jobs are always preceded by large amounts of boring and testing. These operations cost money, and the accumulation of records is necessary to show the uninitiated that the money has been well invested.

The bulkiness of the records is inevitable, because adequate design in earthwork commonly requires a vast amount of factual data. The percentage of significant information may range from almost zero to close to a hundred percent, depending on the qualifications of the man who prepared the subsoil exploration program. Even an excellent record cannot serve a useful purpose unless its contents are thoroughly digested and condensed. This task may require weeks of concentrated effort, and on a large job none of the members of the organization may find the time to tackle it. Some examples are of interest.

The site for a tall office building was explored by test borings, spaced 50 ft both ways. From the results it was concluded that the subsoil consisted of a thick layer of soft clay separated from the surface of the bedrock by a stratum of dense sand and gravel with an average thickness of 10 ft. Therefore it was decided to found the building on clusters of point-bearing concrete piles driven to refusal through the clay into the sand and gravel.

During construction a record was kept of the elevation of the lower end of each pile and of the depth of penetration for the last ten blows. For one pile per cluster, the penetration per blow was measured from the start to the end of the pile-driving operation. The records left no doubt that each pile was driven to refusal. Yet a few months after construction was completed, cracks developed in the main walls and a subsequent survey showed a differential settlement of about two inches in the foundations of this wall. In the next four years the settlement increased to about 7 in. This development took everybody connected with the job by surprise, and widely different opinions were expressed concerning its causes. Yet the real cause was not even suspected, because nobody had paid any attention to the fact that in each pile cluster the elevation at which piles met refusal varied by as much as 15 ft.

Subsequent digest of the pile-driving records showed clearly that the continuous stratum of sand and gravel postulated on the basis of the boring records did not exist. The sand and gravel occurred in the form of thick lenses scattered through the lowest part of the clay deposit. The piles met refusal as soon as they penetrated the uppermost lenses, and the unequal settlement was caused by consolidation of the soft clay between the lenses and bedrock. The discontinuity of the layer of sand and gravel was disclosed quite clearly by the pile-driving for the first cluster. At that stage it would not have been too late to revise the foundation design, but the pile-driving records were filed away before they were analyzed.

In another region a heavy industrial building was to be constructed on a thick layer of inorganic silt. Because unequal settlement would seriously interfere with the operation of the machinery, the specifications as to maximum tolerable settlement were very severe. Therefore, before construction numerous loading tests were performed at the bottom of shafts, at the elevation of the basement floor. Results indicated that the bearing capacity of the silt stratum was inadequate, and a mat foundation was chosen, to rest on point-bearing piles with a length of more than 100 ft.

When the writer was asked to review the project, he noticed a striking discrepancy between the results of the loading tests and the geological conditions. According to the loading tests the bearing capacity of the subsoil was that of a soft, normally consolidated silt, whereas the geologic history of the site left no doubt that the silt was precompressed under a load far in excess of the unit load due to the weight of the proposed structure. Further inquiries disclosed the following fact. The bottom of the shafts in which the loading tests were performed was at

a considerable depth below the water table. The shafts were drained by bailing, and the seepage pressure of the water rising towards the bottom of the shafts had reduced the bearing capacity of the silt to a small fraction of its original value. On the strength of this finding the writer recommended—in spite of the protests of the manufacturers of the mechanical equipment—that the piles be omitted, without changing the design of the mat foundation. The proposal was accepted, and the differential settlement of the structure was well below the specified upper limit.

Grouting in stratified rock

On a construction job abroad, involving large-scale grouting in stratified rock, the capacity of the rock to take grout appeared to be unlimited, and the writer was asked to investigate. The site had been thoroughly explored by borings and a geologic survey, and a record had been kept of every detail of the grouting work. However the records contained no data on ground elevations. As soon as heave observations were started, at the writer's request, it became evident that the ground surface rose during grouting by amounts almost exactly equal to the volume of grout pumped into the rock. When a test trench was dug, it could be seen that the grout had formed thick lenses at areas of contact between different strata. These lenses centered about the grout holes, but most of the joints and fissures above and below the lenses were open.

Geological evidence

Inadequate attention to geological details not disclosed by the borings also may cause trouble. A multiple-arch dam had been built on a sedimentary rock formation consisting of layers of practically impervious shale separated by layers of porous and intensely jointed sandstone. Construction was preceded by a considerable amount of boring and testing.

Before the reservoir was filled for the first time, shear cracks developed in one of the buttresses, and the writer was asked to investigate. During this investigation he discovered that the shale stratum responsible for the shear cracks was underlain by a jointed sandstone stratum having an outcrop within the reservoir area, but none downstream from the dam. If the reservoir had been filled, the joint system of the sandstone would have been invaded by water under a pressure far above the unit load due to the weight of the shale stratum lying above the downstream sandstone. The shale bed would have been lifted off its seat and the dam would have failed by sliding on its base. Once this danger was realized, it was a simple matter to eliminate it by relief wells.

In some cases the essential facts become clear as soon as the observational data are replotted, without further investigation. A high concrete gravity retaining wall had been built on dense sand and gravel above a stratum of clay. Soon after backfilling was started the wall began to tilt outward. The movement of its crest was measured at short time intervals, and the results were plotted to a large scale, one inch equal to one day. On account of inevitable observational errors, the plotted lines were very irregular.

When the crest had moved out 8 in., the owners began to fear that the wall would fail by overturning and sent the displacement record to the writer with a request that he submit proposals for underpinning. When the data were replotted on a single sheet to a scale of 1 in. equal to 10 days, the narrow band occupied by the points representing horizontal displacement showed clearly that the movement could be expected to cease before the crest displacement became equal to one foot. On the large-scale diagram the ups and downs of the measured points had camouflaged the basic trend.

Uninterpreted data

If the observational data are only in the form of tables, they may not even serve as warning signals. A case in point was encountered at the site of an industrial plant located above the seat of brine production. At this site, an area with a diameter of about 300 ft subsided within a few hours through a vertical distance of about 20 ft and changed into a lake. During the process some of the life lines of the plant were cut and adjacent buildings collapsed. Nobody had suspected the danger until the first structure went down. Yet for six years preceding the formation of this sinkhole, the elevation of numerous points in the area had been measured several times a year and the results assembled in tables. Settlement curves plotted from these tables, after the subsidence had occurred, showed that the rate of settlement had already started to increase one and a half years before the catastrophe. For a week before the sinkhole was formed, the settlement amounted to more than one inch per day.

To these few case records many others could be added to show how significant data can be concealed in a maze of details. Furthermore, if decisive factors are overlooked, the conclusions derived from an investigation may be very misleading. For instance a great deal of time and money may be spent on testing at the site of a deep side cut, but if no data are secured on seasonal variations of pore pressure, which in some regions may amount to more than 10 psi, the subsequent performance of the slope may surprise the investigator.

When a novice enters the field of earthwork engineering he enters a jungle of data. If he hopes that his knowledge in soil mechanics will provide him with ready-made solutions for all his problems, he will probably soon conclude that such knowledge operates satisfactorily only in the classroom, and he will gradually forget what he has learned. But if he has a more adventurous spirit and more inquisitive mind, he will take a bushknife and plunge into the jungle. Then he will get his first taste of soil mechanics in action. At the same time he will realize, without having read the writer's prefaces, that it will take him years of wielding the bushknife before he will be justified in considering himself competent in the field he has chosen. After he has become competent he may rise, at a later date, to expertness in earthwork engineering; but that is a long and strenuous journey, and not necessarily successful.

Expertness in this field requires a combination of experience, the keen gift for observation that was characteristic of the ablest engineers among our forefathers, and the insight into the physical causes of the performance of structures which soil mechanics has added to our store of knowledge. To achieve such expertness, effort alone is not enough. It requires innate qualifications over which we have no control.

Initiative and imagination

In soil mechanics, the principal benefit to be derived from training in theory consists in acquiring the habit of associating cause and consequence in earthwork engineering. To retain this habit in the face of complex reality requires initiative and imagination in addition to a thorough knowledge of fundamentals.

Soil mechanics will not consistently serve its purpose until practicing engineers come to realize that it is a supplement to, and not a substitute for, common sense combined with knowledge acquired by experience. Many years ago the bottle-washer in the soils laboratory of the Bureau of Public Roads in Arlington, Va., made the following remark to the writer, "Ef yo' ain' got no college education, yo' sho' does have to use yo' brains." The graduate who enters the field of earthwork engineering must get used to the idea that he has to use his brains and judgment all the time—even in the event that he knows the writer's *Theoretical Soil Mechanics* by heart.

Highway ramp areas become flood control reservoirs

EDWARD FORREST, Chief Civil Engineer, Anderson-Nichols and Company, Boston, Mass.

HARVEY G. ARONSON, J.M. ASCE, Chief Hydraulic Designer, E. L. Pavlo, Consulting Engineer, New York, N. Y.

The step-by-step unfurling of ribbons of concrete and asphalt known as the Interstate Highway Program brings one set of problems to the bridge designer and a different set to the roadway designer. The motorist, bedeviled by stop lights, neon lights and the crawl of heavy traffic on inadequate arteries becomes happier with each new mile constructed. He has learned to accelerate on acceleration lanes, decelerate on deceleration lanes and keep right except to pass. The new 1975 highways will bring him no problems except possibly the one of staying awake on long runs.

The sad municipal engineers

Not becoming happier are suburbia's municipal engineers whose close-packed towns usually find themselves playing host to the new expressway alignments. Traffic-choked metropolitan centers are increasingly seeking to untangle their intertwined roadway networks by constructing belt routes, freeways and other non-stop bypasses to help alleviate traffic bottlenecks. Adding to the local woes are the problems of alignment, right-of-way acquisition, utility relocation, detours, and the general fuss of construction by heavy equipment.

After the usual political harassment over routes and the location of interchanges settles down, the design of the new roadway begins. The beleaguered village engineering consultant, in time, goes through the procedure of approving the drawings. Everything seems fine —just fine.

Then one day it rains. It rains the

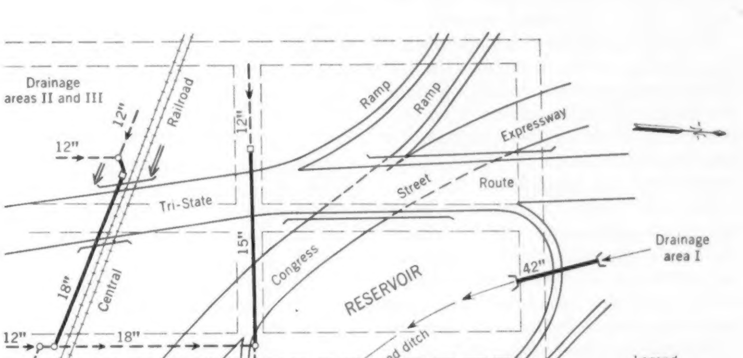


FIG. 1. On new Northern Illinois Toll Highway, at village of Berkeley, Ill., ponding area was created for temporary storage of storm runoff. See also photo above.

next day. It's still raining the morning of the third. Our municipal man then reexamines the new freeway drawings and begins to sweat. Throughout the drawings it seems, he finds notes saying "Connect 18" BCCMP to existing manhole," or "Contractor shall connect drain outlet to existing street inlet at El. 22.0±."

Painfully aware, perhaps, of the underdesigned capacity of his existing municipal storm drainage system or in ignorance perhaps of the tricks played by "time of concentration," he sees only a mass of "extra" storm water further taxing the existing system. Whether the additional impervious run-off area contributed by new highway pavement will overburden his system beyond capacity is often open to question. But the local engineer usually doesn't take a cheerful view of the situation.

A suggested solution

After the furor of impending superhighway construction has been accepted by the community, the highway consultant and the host of local public works departments can still be friends on this matter of roadway drainage. As the swath to be cut through local street patterns and utilities becomes evident, during the design of limited-access roads, there are many little improvements to local systems that can be incorporated in the roadway drawings. Local fears of inundation by "a wall of water" can be dispelled. A little swapping of advantages makes both sides feel better. All-around community improvement is often the result. Most important perhaps, and often practicable, is taking the storm-drainage bull by the horns and really providing a local improvement—and at no cost to anyone.

The time-honored solution of providing ponding areas (sometimes called flood-control reservoirs), long used in the design of major control works, is usually overlooked. The inclusion of such areas in highway drainage systems is easy. And the result is foolproof.

But why bother? Actually, there are many advantages to be gained. First, let's recognize that an alignment through suburban towns and villages usually results in more interchanges per mile than a route out in open country. The geometry that dictates modern interchanges can be the salvation of the designer who is looking for a place to create a storm-water storage area—especially the trumpets, half-trumpets and cloverleafs.

Second, since there's never enough borrow available for the freeway profiles necessary in metropolitan areas, no one will object to some extra excavation between highway ramps. Suddenly we have a ponding area. We have now created a place for the temporary storage of highway drainage, until it can conveniently enter the sewer system of our previously worried municipal engineer. The action is somewhat akin to that of a freight train shunted off on a side track to wait for the Broadway Limited to go by. When peak flows in the local system have subsided, then and only then will the control reservoir begin contributing. No maintenance controls are required other than those dictated by the laws of hydraulics—the size of the reservoir outlet pipe.

Third, the expensive alternative of laying 4,500 lin ft of pipe in a built-up area is avoided.

An example in Illinois

We are pleased, as designers of a part of the new Northern Illinois Toll Highway, to provide an illustration of the working of such a ponding area. The municipality that stood to gain in this case was the village of Berkeley, Ill. See Fig. 1.

Berkeley has a population of 4,000 and is located 17 miles west of Chicago's Loop. The village is provided with separate sanitary and storm-sewer systems. The storm system was built in 1928 utilizing concrete pipe. Design capacities were based on a 10-year storm —a typical practice in municipal work.

Topographically Berkeley is relatively flat, and this too is typical of areas surrounding most of our large metropolitan centers. Flat slopes, designers are aware, dictate the use of larger conduits.

Berkeley, like its neighbors, finds its existing storm system underdesigned—in spots. This too is typical. In the thirties no one could clearly foresee the postwar population explosion, the concurrent move to the suburbs, and the widespread reclamation of low lands for development.

How a ponding reservoir works

Berkeley's new ponding reservoir will work as follows. There will be three drainage areas contributing flow to the existing 30-in. discharge line, as shown in Fig. 1.

The first drainage area formerly discharged overland, and only a small part of the flow was collected by the existing storm-sewer system. Building of the toll highway, however, made it necessary to divert this flow. This was accomplished to the satisfaction of all by providing the reservoir. A 42-in. pipe carries the flow into the reservoir and a 24-in. pipe acts as outlet.

The 42-in. pipe will have a peak flow equal to the peak discharge of the drainage area of 65 cfs for a storm of 25-year frequency. The size is governed only by the upstream maximum allowable ponding requirements of the toll highway, since the reservoir water level does not get sufficiently high to create a tailwater effect.

The 24-in. size of the discharge pipe is governed by the desired flow conditions.

Drainage Areas II and III are drained by an existing sewer system, which will be left intact except for replacement in some areas where pipe of greater structural strength is needed to carry the load of the additional highway fill. This replacement is only a precautionary measure as it is estimated that the soil around the existing pipe has already reached full compression and will thus aid in carrying the new fill load. These two areas have a combined peak 25-year flow frequency of 58 cfs. In the existing sewer system, however, characteristics are such that the maximum flow reaching junction MH "A" is 20 cfs. The remaining flow discharges through an upstream overflow system which has a wide enough area so that the flood level is raised no more than a negligible amount, thus keeping the flow through this system constant at 20 cfs during the time that the combined drainage areas contribute 20 cfs or more. This 20 cfs is not affected by the flow level in junction MH "A", as the flow in the existing sewer system has independent upstream control until it reaches this junction.

A minute-by-minute description

The flow patterns are as follows for a storm of 25-year frequency.

Time, 6 minutes. By this time discharge into the reservoir from drainage Area I has reached 22 cfs. Flow into junction MH "A" from drainage Areas II and III has reached 20 cfs.

The water level in junction MH "A" will be greater than the water level in the reservoir and the junction MH will discharge both downstream into the existing 30-in. sewer, and upstream through the 24-in. reservoir outlet pipe and into the reservoir. See Figs. 2 and 3(*a*). The existing 30-in. sewer has flow characteristics such that the level of flow in junction MH "A" will control its discharge.

This upstream flow could have been prevented by a small change in the impounding characteristics of the reservoir, without affecting the overall desired flow conditions. However, it was deemed desirable since it reduced the early discharge of the existing storm-sewer system, thus improving early downstream flow conditions.

Time, 32 minutes. After this period of time, discharge into the reservoir from drainage Area I has reached the peak flow of 65 cfs. See Fig. 4.

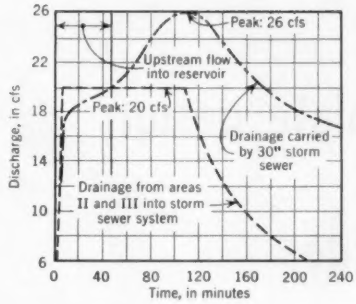


FIG. 2. Hydrograph for 25-year storm shows discharge from Areas II and III into existing storm-sewer system.

Flow into junction MH "A" from drainage Areas II and III remains at 20 cfs, as previously explained, even though the drainage areas have reached a peak discharge at 58 cfs.

The flow level has risen both in the reservoir and at junction MH "A." However the level of the reservoir has risen at a faster rate because of the heavy discharge into it whereas the small increase in water level at the MH junction is caused by a need for a slightly greater downstream flow to compensate for the diminishing upstream discharge into the reservoir. This diminishing upstream discharge is due to the decreasing difference in water levels.

Time, 50 minutes. Discharge to the reservoir from drainage Area I has dropped to 48 cfs. Flow into junction MH "A" from drainage Areas II and III remains at 20 cfs.

The water level has risen both in the reservoir and at junction MH. However, the reservoir level has reached the water level at junction MH "A" and there is no flow between the two. From this time on, the reservoir will discharge into junction MH "A." See Fig. 3(*b*).

Time, 120 minutes. Flow into junction MH "A" from drainage Areas II and III has fallen below 20 cfs and all flow from these drainage areas will now discharge into the storm system. The overflow system is now idle.

Flow into the reservoir has fallen to 18 cfs.

Discharge from the reservoir to MH "A" has increased to 9 cfs.

The water level has risen both in the reservoir and at junction MH. However, the water level at junction MH "A" has reached its peak. This is the point at which the existing 30-in. sewer will obtain a maximum combined discharge from all three drainage areas of 26 cfs.

This late storm peak compares very favorably with the former early storm peak of 20 cfs for a considerably smaller drainage area. See Fig. 3(*c*).

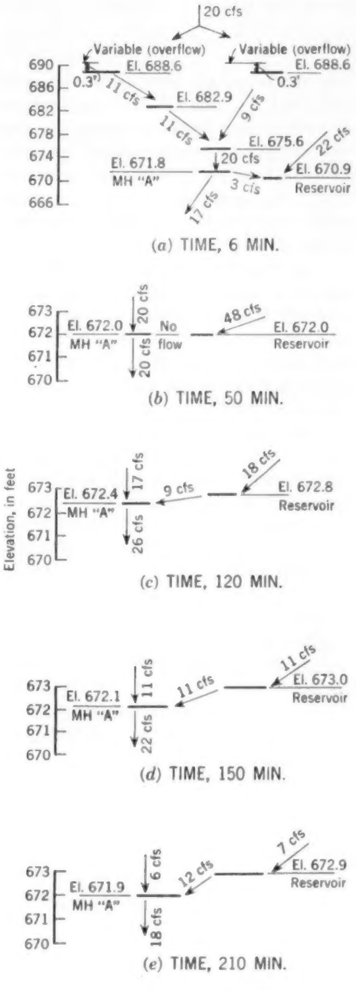


FIG. 3. Relative water levels at junction MH "A" and in reservoir are shown for five time intervals.

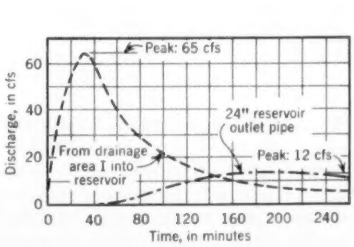


FIG. 4. Hydrograph for 25-year storm shows discharge into reservoir from drainage Area I and into 24-in. reservoir outlet pipe.

Time, 150 minutes. Flow into junction MH "A" from drainage Areas II and III has fallen to 11 cfs and the water level in MH "A" has dropped to El. 672.1.

The reservoir has risen to a level such that the difference in head between the reservoir and junction MH "A" causes a reservoir discharge equal to the reservoir inflow. This is the maximum water level reached in the reservoir.

Discharge in the existing 30-in. sewer has fallen to 22 cfs. See Fig. 3(*d*).

Time, 210 minutes. The flow from drainage Areas II and III has fallen to 6 cfs and that from drainage Area I has fallen to 7 cfs.

Both the reservoir water level and the MH water level are falling. However, hydraulic characteristics result in a peak reservoir discharge. This is due to the greatly reduced total discharge of 18 cfs, which in turn requires a reduced water level at junction MH "A." At the same time there is only a slight drop in the reservoir level below its peak. See Fig. 3(*e*).

This peak reservoir discharge of 12 cfs is considerably less than the 65-cfs peak flow of drainage Area I, and satisfactorily meets the overall design conditions.

Time, 36 hours. The reservoir has emptied.

Conclusions

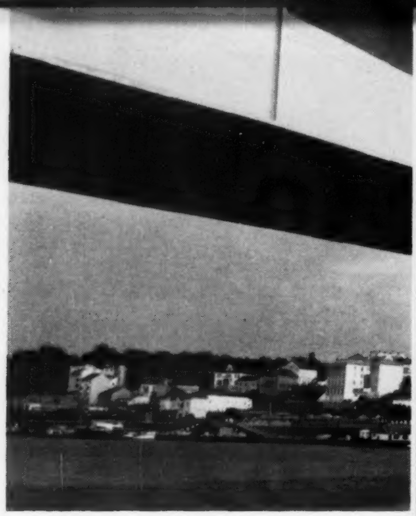
Admittedly the design and construction of a ponding area for the purpose here outlined is not outstanding as an engineering feat. It is, however, a way in which the relationship between the state and the local community can be made smoother. As the Interstate Highway Program gathers momentum in the years ahead, additional opportunities for cooperation will present themselves to highway design project managers. Local drainage headaches are to be found in parts of all the 48 states. Here is one way to alleviate such situations.

The reassured Berkeley municipal engineer in this case was Eric H. Smith of the Edwin Hancock Engineering Company of Chicago. The sponsoring agency was the Illinois State Toll Highway Commission, with George L. Jackson, M. ASCE, as chief engineer. The overall consultant to the Commission is Joseph K. Knoerle & Associates, Inc., with George F. Noble as chief engineer. For E. Lionel Pavlo, section engineer, the project manager is Lester Balaban, J.M. ASCE, and resident engineer, Frank J. Venezia.

The contractor on the job is Western-Boyle-Ryan-Healy, joint venturers of Idaho and Illinois.

Orthotropic plate design for steel bridges

ROMAN WOLCHUK, A.M. ASCE, Head, Bridge Department,
Frederic R. Harris, Inc., Consulting Engineers, New York, N. Y.



Save River Bridge in Belgrade contains

A remarkable development in steel bridge construction has been taking place in Europe, as evidenced by the many lightweight, slender and esthetically appealing girder bridges, with spans up to 856 ft, that have been built there in the past decade.

A new bridge system, combining steel girders and cross-stiffened steel plating in one structural unit, has evolved from the continued efforts to reduce dead weight by eliminating heavy decks and to secure the most efficient utilization of materials.

Weight-saving becomes especially important in long-span girder designs, where, in conventional construction, the dead load may account for up to 80 percent of the total design moment. Replacing the heavy concrete deck by steel plating was proposed in the 1930's in a type of construction known as the "battledeck floor." However, the system was not successful since it failed to utilize steel in the most effective manner, especially in the longer spans.

A step forward in design was made with the transition from the simple concept of individual bridge elements (slabs, stringers, floor beams, main girders) designed independently for maximum loads, to a system in which all the elements are integrated into one space grid. The high degree of statical indeterminacy of such systems results in a good load-distributing capacity and a much higher factor of safety for the structure. The now common "composite construction," with the concrete deck fully participating in the main girder stresses, may be treated as such a space structure.

Practical application of the grid system with a steel-plate deck was made possible by the development of welding, and several such bridges were erected in Germany in the 1930's. In the course of further development the rib spacing was decreased in order to utilize the plating more effectively and to improve its stiffness, but the computation of such a closely spaced grid became increasingly complicated.

A radical solution to this problem was to disregard the finite structure of the grid entirely and to treat the system as a *plate*, with elastic properties distributed continuously. Since the stiffness of such an idealized plate in the longitudinal direction of the bridge is different from that in the transverse direction, the plate is designated as "orthogonal-anisotropic" or, using the now common abbreviation, as an "orthotropic plate."

The principal advantage of such an approach is a complete utilization of the deck plate, which, in addition to its action as an independent carrying element between ribs, also acts as the upper flange of the longitudinal ribs, floor beams and main girders, and contributes to the utilization of the torsional rigidity of the ribs, which is disregarded in the conventional grid design. Furthermore, the design of the plating is made independent of the number or spacing of ribs, and the designer is free to arrange them as closely as necessary, without fear that computation difficulties will result (Fig. 1). From a theoretical point of view, the closer the mesh the better the agreement between assumption and reality, and a dense cellular structure may be regarded as a desirable approximation to nature's own way of building.

Actually, the minimum rib spacing is governed by practical construction considerations, and therefore local effects of discontinuity must be considered in the design.

When the first bridges with orthotropic steel-plate decks proved to be a complete success (1947-1951), many more such structures, both plate-girder and suspension bridges, were built in Germany, and a few in other European countries. In Germany the new structural system is already well established. While composite construction prevails for spans of intermediate length, the lightweight orthotropic-plate construction is now considered a standard solution for long-span girder bridges in steel.

The orthotropic-plate problem was first theoretically solved by Huber (1923), who gave the general differential equation for such a plate in the form:

$$K_x \frac{\partial^4 w}{\partial x^4} + 2H \frac{\partial^4 w}{\partial x^2 \partial y^2} + K_y \frac{\partial^4 w}{\partial y^4} = p$$

where x and y are the horizontal coordinates of the plate; w the vertical deflection; p the loading per unit area; and K_x and K_y the plate stiffness values in the x and y directions. The term H

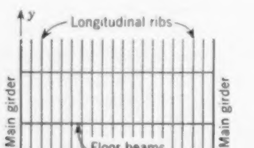


FIG. 1. Scheme of a bridge with orthotropic-plate deck.

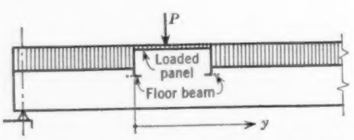


FIG. 2. For the design of longitudinal ribs under local loads as studied by Cornelius and Mader, the elastic properties of the orthotropic plate were assumed to be continuously distributed only in areas outside the loaded panel.

the world's longest plate-girder span, 856 ft. Photo by MAN.

Trapezoidal box-shaped ribs are considered the best type for a torsionally stiff system. Photo by DEMAG.

is a function of the torsional stiffness of the orthotropic plate.

This equation was first applied to cross-stiffened steel plating by Cornelius, who gave solutions and computed constants for the basic cases (1947-1952). The expressions for moments, shears, and other values needed for design of the orthotropic plate are obtained in the usual way from the general solutions for each case of loading, which has to be represented by a Fourier series. The plate is usually treated as an infinitely long plate strip simply supported along the main girders, which are regarded as rigid.

While the solution for the idealized plate with assumed continuous properties describes adequately the elastic behavior of the steel deck as a whole, it still disregards the practically important local deformations and stresses, which occur, as a result of the actual discontinuity, under a wheel load placed between the panel points of the stiffened plate.

To evaluate such local conditions, a refinement of the original approach was proposed by Cornelius and Mader. The elastic properties of the orthotropic plate were assumed to be continuously distributed only in areas outside of the loaded panel. See Fig. 2. However the discontinuous properties of the panel directly under load were recognized.

This approach, requiring considerable mathematical skill and a great amount of numerical work, was used in the design of the Save River Bridge (Fig. 3) and other structures.

With the increasing number of applications of the orthotropic plate system, the question arose as to whether the numerical results needed for dimensioning could be obtained in a simpler and more direct way. Such a method, well suited to practical design purposes, has been developed by Pelikan and Esslinger (1958).

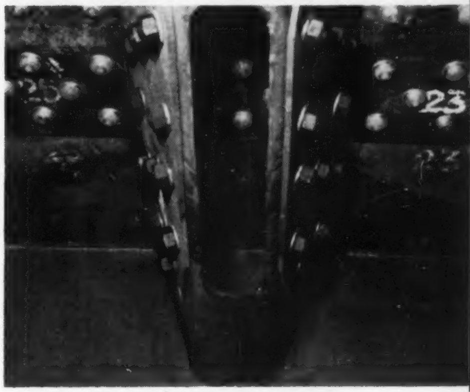
In this two-step method the transverse floor beams are first regarded as rigid and the deck plating with the longitudinal ribs is treated as a continuous orthotropic plate on unyielding supports. A correction due to the actual elastic flexibility of the floor beams is computed in the second step and superimposed on the results of the first computation. Numerical results obtained from this design procedure, distinguished by its relative simplicity, are very close to those obtained by the much more involved earlier methods. It should be noted that all the design methods discussed above are based on the theory of first order, with no allowance for the effect of deformations on the forces acting in the system.

To obtain the total maximum stresses in the plating, the stresses in the deck acting as an orthotropic plate must be superimposed on the stresses in the deck acting as the top flange of the girders. With a span length more than three times the girder spacing, the whole width of the deck can be considered effective as the top flange. This has been confirmed by stress measurements on existing structures.

Local stresses in the flat plate, acting between the ribs, are not included in the above considerations and must be treated separately.

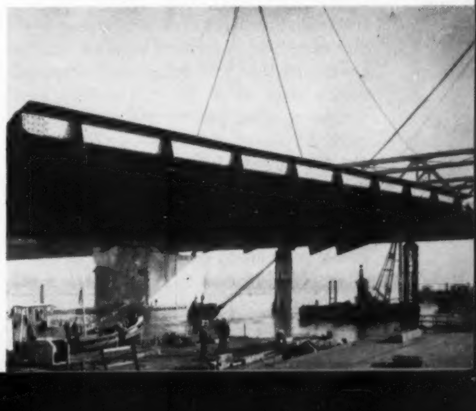
The plate-like behavior of the orthotropic steel-plate deck has been confirmed by many deflection and stress measurements made on test plates as well as on existing structures. A concentrated load placed on the plate is distributed over a wide area to several adjoining floor beams, while the directly loaded longitudinal ribs behave as beams on elastic supports.

The agreement of the computed and measured values is good for the loads in the usual working range. However, the theoretical computations of critical



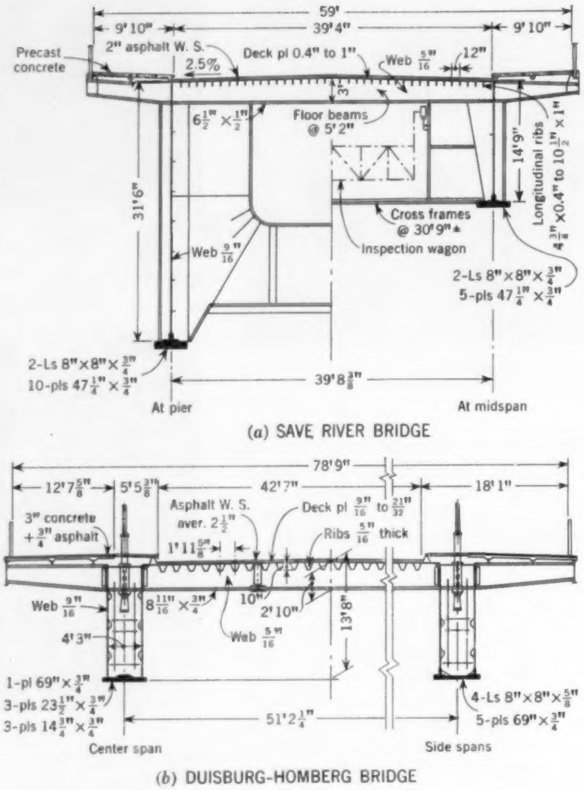
Box-shaped ribs were field spliced with high-strength bolts on Duisburg-Homberg Bridge over the Rhine. Photo by DEMAG.

In prefabrication of units, shop welding of ribs is done in trough position on tilt tables. Photo by MAN.



A panel of steel deck plating of the Rhine bridge Manheim-Ludwigshafen being lifted. Photo by DEMAG.

FIG. 3. On continuous - girder Save River Bridge (a) in Belgrade, completed in 1956, with spans of 246, 856, and 246 ft, the orthotropic plate with flat-bar ribs is supported on two girders 39.7 ft apart. Design and fabrication by MAN (Maschinenfabrik Augsburg-Nurnberg). Duisburg-Homberg Bridge (b) over Rhine, opened in 1954, is bridle-chord suspension bridge with spans of 421, 936, and 421 ft. Here orthotropic - deck plate has torsionally stiff trapezoidal ribs. Design and fabrication by DEMAG, Duisburg.



loads consistently yield results many times lower than the loads actually observed at failure.

Extensive tests of elastic behavior and ultimate strength were made by Prof. Kloeppel in connection with the design of the Save River Bridge in Belgrade. In one of the tests a simulated wheel load was placed over a longitudinal rib of a half-scale model of plating and the load-deflection curves were obtained as shown in Fig. 4. The load corresponding to the maximum allowable design stress in the rib was 2.06 tons; the computed ultimate load was 5.4 tons. However, measurements indicated perfect elastic behavior of the system up to a load of 4.1 tons; the first crack in the rib occurred at a load of 48 tons and spread over the entire depth of the rib at 56 tons.

After the load exceeded the purely elastic limit, there was no rapid and unrestrained increase of deflections as usually observed in flexural tests on simple beams. Instead, the deflections increased only a little faster, but still linearly, and consisted of an elastic and an inelastic part. At a load of 6.5 tons, or 3.15 times the theoretical design load, the permanent deflection was 0.75 mm or, with the floor beam spacing of a model of 750 mm, only 1/1,000 of the rib span. Since permanent deformations of such small order are entirely harmless, a design load in excess of the theoretical value based on "allowable stress" was used. (All tons are metric.)

With the observed ultimate load of 56 tons, the actual factor of safety, using the theoretical design load value, was $56/2.06 = 27.1$.

Similar behavior was observed in full-scale tests on 10-mm deck plates of structural-grade steel rigidly supported by ribs spaced 300 mm on centers. Under a double wheel load, fully elastic behavior was observed up to 32.5 tons, and the plate broke under a load of 276 tons. Thus, with the design wheel load of 10 tons, the factor of safety against inelastic behavior was 3.25 and the safety factor against breaking was 27.6. It should be noted that the carrying capacity of an actual bridge plate is still higher because of the elastic flexibility of the supporting ribs and the load distributing action of the asphalt wearing surface.

Similar observations of elastic behavior and high strength of plating were made in the earlier American tests on battle-deck floors.

It is seen that the orthotropic-steel-plate system possesses reserves of carrying capacity much in exces of the usual requirements for members in tension or bending. While the actual safety factors for steel members designed for the currently prescribed "allowable stresses" are approximately 2 for tensile bars and 3 for rectangular bars in flexure, the factor of safety for orthotropic plating under a wheel load ranges from 20 to 30, or 10 times as much!

This high load-carrying capacity of an orthotropic-plate deck is explained by a favorable combination of the effects of the plasticity of steel and membrane action, which is of increasing importance as the deflections in the system increase. It is very important to note that in such systems the applied loads are not proportional to the stresses they produce; the loads grow faster than the stresses. An adequate theoretical interpretation of these phenomena could only be given by a second-order plate theory in the plastic range, which also might give approximate practical formulas for ultimate loads. However, the design is not yet sufficiently developed to make such a theory possible. Thus at present the necessary data on the ultimate behavior of orthotropic plating can only be obtained in an empirical way.

In any system where the increasing loads are no longer proportional to the maximum stresses in the structure, its actual safety can only be expressed as a ratio of the critical load to the working load, which is quite different from the ratio of the strength or plastic limit of the material to the stress under the design load. Thus the "allowable-stress" approach can be grossly misleading if applied to orthotropic steel plating, characterized by the peculiar load-stress relationships and the safety reserves discussed above. Obviously, the same value of "allowable stress" would have an entirely different meaning for the various parts of the structure, making the factors of safety for the orthotropic plating unreasonably high as compared with the other structural members of the bridge.

A rational design procedure could be based on theoretical or experimental determination of the loads considered critical with respect to strength or deformation of the system, and then establishing working loads with a desired factor of safety. This approach was actually used to adjust the theoretically computed values in the design of the Save River Bridge and resulted in considerable economies of structural steel. Such a procedure, however desirable, must still be regarded as impractical for general use, since the costly and time consuming tests are feasible only for structures of major importance. However, with further theoretical development and the accumulation of more empirical data regarding the behavior of orthotropic plates, a gradual transi-

tion to the principles of "ultimate design" may become possible.

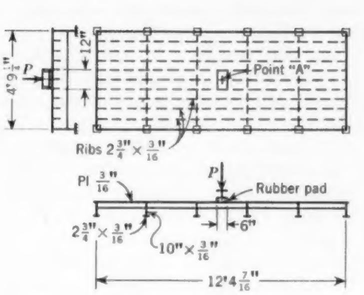
The present compromise solution is to use design methods based on the first-order theory, with higher "allowable stresses" applied, to account, at least partially, for the large carrying-capacity reserves of the system. In this connection, the high stresses, even up to the plastic limit of the material, variously proposed and used in design, should not be interpreted in the usual sense and regarded as perilous, since these values are only indirect expressions of the "ultimate design" principles involved. The experimentally established elastic behavior of the orthotropic plating beyond the limits predicted by the first-order theory should also be kept in mind when "allowable stresses" for the design are discussed.

The upper limits of allowable stresses for the orthotropic plating are often governed by maximum deflections rather than strength considerations. It is considered desirable to keep the deflections small in order to prevent cracks in the asphalt wearing surface. For this reason the minimum thickness of plating is now limited by current German bridge specifications to 15/32 in., with a rib spacing of 12 in. However, the necessity for such a limitation is debated.

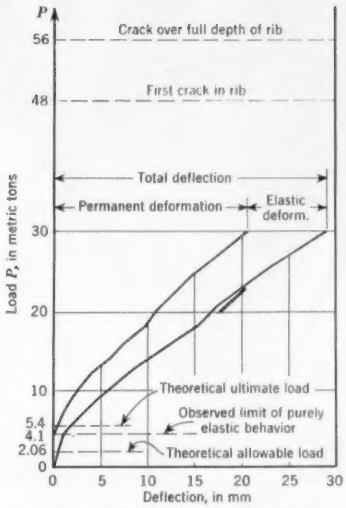
For the design of flat plating acting between ribs, stresses of 27.2 kips per sq in. (ksi) for St 37 steel and 38 ksi for St 52 steel, corresponding respectively to the American structural grade and low-alloy steels, are currently allowed by the German bridge authorities, the value of 0.9 times the plastic limit being allowed for the "comparative stress" under a biaxial stress condition in the plate.

It should be noted that a similar working stress of 28 ksi was recommended by the American Institute of Steel Construction for the structural-grade steel plating in the battle-deck floor system.

In many current designs for orthotropic plate decks using the prescribed

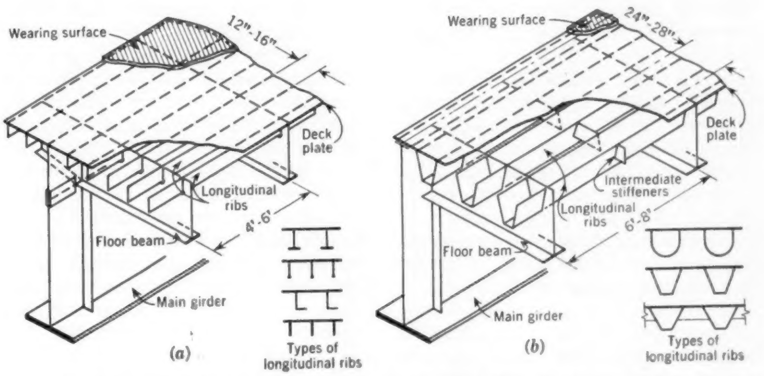


(a) TEST ARRANGEMENT



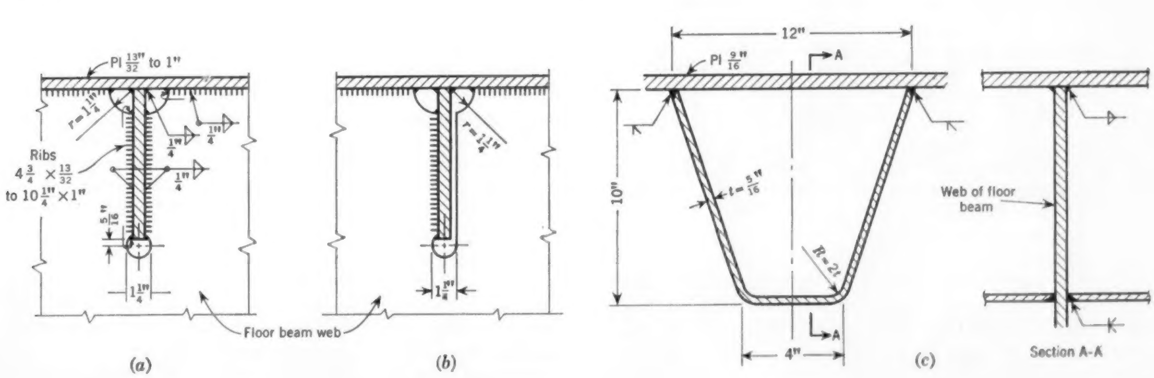
(b) LOAD-DEFLECTION CURVE FOR POINT A

FIG. 4. Load-deflection curve was obtained from tests by Kloeppel on a half scale model of Save River Bridge plating.



↑ **FIG. 5. Two basic types of orthotropic steel-plate decks are used: (a) with torsionally soft ribs, and (b) with torsionally stiff ribs.**

Fig. 6. Continuous fillet welds are used to weld ribs to under side of plating. In (a) details of a welded rib of the Save River Bridge are shown, in (b) an alternative arrangement, and in (c) details of welded ribs for the Duisburg-Homberg Bridge. ↓



Under-side view of the Rhine bridge, Duisburg-Homberg. Photo by DEMAG.

minimum sizes, computation of local stresses in the flat plate is omitted entirely.

In the design of longitudinal ribs for wheel loads and superimposed stresses from the main girder action, stress peaks close to the plastic limit have been allowed in some designs. Aside from safety considerations with regard to the rib as part of the orthotropic plate, discussed above, such stress peaks are quite in order also in the main girder system because of their strictly local character. If, in an extreme case, a stress up to the yield point should be reached at one point in a rib, surrounded by material subjected to a considerably lower stress intensity, no plastic deformation can develop, and therefore such a condition should not be considered dangerous. Similar local stress concentrations are found in any conventional structure around rivet holes or at changes in cross section but it is common practice to disregard them.

According to current German bridge specifications, the longitudinal ribs of orthotropic plating under the combined effects of local loads and main girder action should be designed with the same stresses as those allowed for simple members. However, for future specifications, higher allowable tensile stresses for such superpositions are planned (25.5 ksi for St 37 steel and 38.4 ksi for St 52 steel). Reduction coefficients for stresses in the ribs due to local conditions, to be superimposed on the main girder stresses, have also been suggested.

Development is still in progress and there is as yet no general agreement on some design problems. However, the various current tentative specifications and design methods based on the first-order theory provide workable procedures that are comfortably on the safe side, and can be used with confidence in view of the large and still untapped safety reserves of the orthotropic plating.

The two basic systems of orthotropic steel-plate decks used at present—characterized by torsionally soft and torsionally stiff ribs—are shown in Fig. 5.

In the torsionally soft system, flat bars, bulb shapes, angles and inverted T-sections have been used as longitudinal ribs, running continuously through slots in the webs of the floor beams. Now preference is given to flat bars, spaced approximately 12 in. on centers, since they can be used in any required size, and are the easiest to splice and to thread through the floor beams. Rib sizes vary from 5 in. x 7/16 in. to 10 in. x 1 in.; the deck-plate thickness may vary from 7/16 in. to 1 in. Both structural-grade steel and weldable high-strength steels are used, as required.

Ribs are welded to the under side of the plating by continuous fillet welds. To avoid excessive warpage and residual welding stresses in the deck plate, it is important to keep the weld sizes to a minimum. It is also desirable to avoid end craters and intersections of fillet welds. A solution to these problems is shown in Fig. 6 (*a*). The circular cutouts in the webs of the floor beams serve two purposes: (1) the longitudinal rib welds can be run continuously through intersections, while the vertical and transverse welds can form closed loops, as indicated by the arrows; (2) stress concentrations at cutouts are minimized.

Large shrinkage stresses may occur in parts of the floor-beam webs between the closely spaced longitudinal ribs. This can be avoided by the arrangement shown in Fig. 6 (*b*).

Out of the many types tried in the torsionally stiff system, the trapezoidal box-shaped ribs shown in Fig. 6 (*c*) are now considered best. The rib thickness seldom exceeds 5/16 in. and even a rib thickness of 3/16 in. has occasionally been used. In spite of the thinness of the material, the box ribs are considered corrosion proof, since no corrosion can take place in the airtight interior, and the smooth outside surface can be easily maintained. Unlike the torsionally soft ribs, the box-shaped ribs are usually butt welded to the webs of the floor beams at each intersection by means of bevel groove welds. These welds must develop the full tensile value of the rib and must be made with particular care. To give the system more torsional rigidity, additional stiffening plates between the box ribs have recently been introduced. See Fig. 5 (*b*).

Field splicing of box-shaped ribs is done by means of high-strength bolts handled through a hand hole provided in the bottom of the rib at the location of the splice. The system with torsionally stiff ribs has the advantage of a better load distributing capacity, resulting in savings of material. On the other hand, the box-shaped ribs involve more labor for fabrication than the simple ribs of the torsionally soft system.

Units of orthotropic plating are shop-fabricated in sizes governed by transportation possibilities. Panels up to 58 ft x 18 ft have been fabricated as one weldment for transportation by barges. For the welding of flat ribs, a method known as Elin-Hafergut welding has been successfully applied. In this method, coated electrodes approximately 5 ft long are laid flat end to end along the joint to be welded and then covered by a hollowed copper bar 2 in. x 2 in. as shown in Fig. 7. After the welding circuit is closed, welding proceeds automatically through melting of the electrode. Welds of uniform quality up to 20 ft in total length can be obtained by this method with a speed of approximately 8 in. per min. Welding of several ribs can proceed simultaneously. The simple operations of this method do not necessarily require qualified welders. Warpage and residual welding stresses are reduced since the copper bar absorbs heat to a considerable extent.

Main girders used in conjunction with orthotropic-plate decks are of conventional type, except for the omission of the upper flanges. They can be welded or riveted if larger lower-flange areas are required.

For erection, the cantilever method is generally used. The light, flangeless sections of the girders are cantilevered first, then the preassembled panels of the orthotropic plating are placed on them. The longitudinal field splices between the plating and the girder webs are usually riveted. Welding, riveting, bolting or combinations of these methods are used for the field splices of the deck plating.

For the wearing surface, asphalt is most often used. The total thickness ranges from 1¾ in. to 2½ in. and consists of a coat of bituminous paint, a thin layer of mastic or corrugated aluminum foil, and two layers of asphalt, each ¾ in. to 1 in. thick. Considerable experience with asphalt wearing surfaces has shown that their performance depends on careful design of mixes, good workmanship, and sufficient stiffness of the steel deck. Mechanical means for improving the bond of the asphalt to the deck, such as welded flat bars or wire mesh, are now considered superfluous and should not be used since the additional welding that would be

involved might weaken the steel deck.

Non-asphaltic wearing surfaces, such as latex compounds or epoxy resins, applied in thicknesses of 3/8 in. to 1/2 in., are more expensive but have the advantage of lighter weight.

The cost of the wearing surface is only a small fraction of the total cost of the bridge and in case of any damage, the wearing surface can be easily and cheaply repaired or replaced. In cases where cracks have appeared in the wearing surface, no corrosive damage to the steel deck has been found. For such reasons most bridge designers are now of the opinion that the importance of wearing-surface problems should not be exaggerated, and that the steel construction should not be unduly penalized by too rigorous stiffness requirements.

Weight savings resulting from the elimination of concrete decks and from a better utilization of structural steel in the orthotropic-plate system are shown by a comparison with typical bridges of conventional design in Table I. It should be noted that the first four structures listed—those with orthotropic-plate decks—were designed for traffic loads substantially heavier than those in the current AASHO specifications. Similar dead-weight savings are obtained for suspension bridges, none of which are in the table.

In the longer span range, steel savings are even more remarkable. The new Cologne-Muelheim suspension bridge required a total of only 5,810 tons of steel, although it replaced a structure containing 12,890 tons of steel. The steel weight of the new Save Bridge in Belgrade is 3,800 tons, replacing a destroyed suspension bridge of 6,800 tons.

Substantial savings due to lightweight construction can be obtained in the substructures of bridges, especially where foundation conditions are difficult. Since longer spans are economically feasible, the number of piers can be reduced.

The saving in weight of steel is partially offset by the increased cost of fabricating the orthotropic steel plate. According to German fabricators with experience in this type of construction, with whom the writer has had an opportunity to discuss fabrication problems, approximately 20 percent more man-hours per ton of steel are needed for an orthotropic-plate bridge than for a long-span plate-girder bridge of conventional type.

In the United States a 20-percent increase in labor ought to increase the unit price of fabricated steel by not more than 10 percent, or a 10-percent saving in steel weight should make the total steel cost of a conventional and an orthotropic-plate structure equal. In such a case the price differential between a reinforced concrete deck and an asphalt wearing surface would still result in a net saving, in addition to savings in the substructure and the better load-carrying capacity of the bridge.

Based on the above considerations, a superstructure cost saving of approximately 15 percent is obtained for a continuous bridge of orthotropic-plate design in the 375 to 400-ft span range with a steel weight of 75 psf, as compared with a typical conventional structure in the same span range. Savings would be larger as the spans increase in length. For the longer spans the weldable steels of T-1 type may offer interesting possibilities.

To obtain opinions and comments from fabricators of structural steel in the United States, preliminary designs were submitted to a number of firms. While some were skeptical about the economy of the system, several indicated their interest and readiness to bid on this type of construction and quoted unit prices within the predicted range.

Now that significant progress has been made in other structural fields such as those of reinforced concrete and aluminum, steel construction cannot remain at a standstill and retain its competitive position. The orthotropic-plate system, which represents unquestionable progress in bridge building, points the way to new and more efficient methods of utilizing structural steel by developing the still unexhausted potentialities of the material.

The writer wishes to express his appreciation to the firms of MAN-Werk Gustavsburg and DEMAG-Duisburg and to other organizations and engineers whose technical information and photographic material have aided materially in the preparation of this article. He also wishes to thank Prof. Dr.-Ing. W. Pelikan of the Technical University in Stuttgart for most valuable information and for his review of the article.

A list of pertinent literature on the subject may be obtained by addressing the writer, in care of Frederic R. Harris, Inc., 27 William St., New York 5, N. Y.

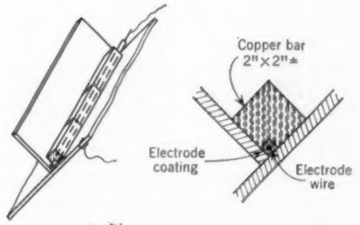


FIG. 7. The Elin-Hafergut method of making fillet welds in trough position does not necessarily require qualified welders. Warping and residual welding stresses are reduced since copper bar absorbs much of the heat. Photo by MAN.

TABLE I. Unit weights and steel quantities for some existing bridges

	Year	Spans, ft.	Steel Weight, psf of bridge	Total Dead Weight, psf
Bridges with orthotropic plate decks:				
Mannheim-Ludwigshafen, Germany	Under constr.	300-300-300	60	82
Weser Bridge Porta, Germany	1954	209-256-348	55	100
St. Alban Bridge, Basel, Switzerland	1954	189-443-189	73	100
Save Bridge, Belgrade, Yugoslavia	1956	246-856-246	105	138
Bridges with concrete decks:				
Passaic River Bridge, New Jersey	1951	220-275-375-275-220	90	170
Quinnipiac River Bridge, Connecticut	1957	258-387-258	88	210

Girder and slab construction for Dougherty Hall at Villanova University. Note column forms made of four pieces of stock lumber of same width as girders carried. Girder forms are made of three pieces of 2 x 12-in. lumber. Joists of 2 x 12's carry plywood deck. Spacing between girders is 12 ft to match three pieces of plywood. Henry D. Dagit & Sons, architect; McCormic-Taylor Associates, engineers; Joseph R. Farrell, Inc., builder.

JOSEPH R. FARRELL, M. ASCE, President, Joseph R. Farrell, Inc., West Conshohocken, Pa.

ECONOMY IN CONCRETE BUILDINGS

Large construction savings through small design changes

Major economies in concrete buildings can be achieved by giving consideration in the design stage to such features as the methods of forming used by constructors and the commercial sizes of lumber. It is essential first to recognize that neither the cost nor the weight of a small amount of "extra" concrete in beams is of top importance. Perhaps 10 cu yd of concrete costing \$25 per cu yd for purchase and placing (as added concrete only) will simplify forming out of all proportion to its \$250 of added cost for a 100 x 200-ft building of three or four stories. And the 25 tons of extra weight, spread over some 25 footings, is negligible in almost all cases. Minor changes in design can achieve large savings.

It was natural for the engineers who designed the first concrete buildings to follow the pattern of the beam-and-girder, timber-and-steel structures of the day. A typical design would have columns spaced about 20 ft on centers both ways with 12 x 20-in. girders running in one direction and 8 x 16-in. beams at the third points, spaced therefore about 6 ft 8 in. on centers. The columns supporting the roof might be 14 in. square, those supporting the floor below the roof 16 in. square, those supporting the next lower floor 18 in. square, and so on.

The forms were all made of dimensioned lumber sawed on the job to the proper size and spliced together with battens. A ledger board was nailed to the battens of the beam sides at the proper distance below the under side of the slab form to support 2 x 4's or 2 x 6's to act as joists to carry the slab forms. A kicker was nailed to the shore head on each side of the beam and girder forms to prevent them from spreading as a result of concrete pressure.

The girder forms had to be cut at each beam and the column forms had to be cut out on four sides to receive the beams and girders. In addition, the slab forms had to be cut out at the four corners of each column because the column was wider than the beams and girders it supported. The practice of reducing the size of the columns on each succeeding floor as the building rose in height made it necessary not only to remake the column forms for each floor, but also to lengthen the beam and girder forms which were supported by the columns. The boards in the slab forms which had been cut out for the corners of the large columns at the first supported floor would not fit the reduced columns of the second supported floor. This system was very wasteful of lumber and labor.

Numerous systems of concrete design have been developed over the years in an effort to reduce the cost of concrete structures. Real progress has been made. The flat slab has been developed in many forms by engineers, each with a good idea. In the American way, when one man conceives a good plan, each man who uses it tries to improve on it.

The beam-and-girder design has been modified by the use of concrete joists formed by metal pans of various kinds, which have effected savings in lumber and labor. Use of plywood for concrete forms not only has resulted in great savings in formwork but has improved the appearance of the concrete so that it is acceptable as a finished material in many fine buildings.

The concrete designer has several systems from which to chose: normal flat slab with capitals and drop heads; flat slab without capitals and drop heads; plate slabs; girder and slab; four-way slab supported on beams running from column to column; joist and slab formed by pans; joist and slab formed by wooden joist forms, set 4 ft apart, the width of a sheet of plywood; either flat-slab or joist-and-slab construction supported on rigid frames for long spans; and the various types of thin-shell roofs, to name a few.

The following suggestions can yield economies in construction with any of the various framing systems:

Parking structure at Upper Darby, Pa., of rigid-frame and joist-and-slab construction. Note that the rigid-frame forms are prefabricated, ready to set. The joist forms are made of three pieces of stock lumber and set 4 ft plus apart to fit the plywood. Metal-pan and flat-slab construction is used in odd-shaped bays.

Structure nearing completion is seen at right. Some reshoring of lower floors has been done to permit early release of forms for the next lift. Note portable tower hoist for placing concrete where needed. John B. McClatchy is owner of the structure, Earl P. Allabach, engineer, and Joseph R. Farrell, Inc., builder.

1. Columns should be the same size from foundation to roof. Then beam forms as well as column forms can be reused from floor to floor without alteration.

2. Spacing of columns from center to center should be uniform throughout the building as far as possible. This makes for simplicity and allows mass production of formwork.

3. Column centers should be set so that the distance *between faces of beams* will be multiples of 4 ft plus one inch, permitting whole sheets of plywood to be used without cutting for slab forms. For instance if the width of the beam or girder supporting the slab is 14 in., the column centers should be 21 ft 3 in. apart, not 20 ft. In flat-slab construction, the drop heads should be 8 ft, 10 ft, or 12 ft square, and the distance between drop heads should be a multiple of 4 ft plus one inch. The extra inch facilitates stripping of the forms.

4. Columns should be no wider than the girder they support. Then the column form becomes a simple rectangular box without cutouts, and the slab form does not have to be cut out at each corner of the column.

5. Beams should all be of one depth on each floor and of a depth permitting the use of stock lumber. This depth can be established by adding an even number of inches plus $\frac{5}{8}$ in. (the thickness of plywood) to the depth of the concrete slab to establish the total depth of the beam. Stock 2-in. lumber is about $\frac{3}{8}$ in. or $\frac{1}{2}$ in. scant of the nominal size in both directions, thus a 2×12 is actually $1\frac{5}{8} \times 11\frac{1}{2}$ in. The $1\frac{5}{8}$-in. beam bottom is placed between the side forms. Thus the depth of the concrete beam below the $\frac{5}{8}$-in. plywood, using 2×12's, as the beam sides, is $11\frac{1}{2} - 1\frac{5}{8} = 9\frac{7}{8}$ in. If the slab is 5 in. thick, the total depth of the beam is $9\frac{7}{8}$ in. $+ \frac{5}{8}$ in. $+ 5$ in. $= 15\frac{1}{2}$ in. If calculations show that the economical beam depth for a given span is 14 or 15 in., make the beam $15\frac{1}{2}$ in.

Stock lumber can be purchased in nominal sizes of 2×2, 2×3, 2×4, 2×6, 2×8, 2×10, 2×12, and 2×14, so there is a wide range for selection. If the beam depth is too great to use a 2×14, two pieces of lumber can be used together to make the beam sides; each will be about $\frac{1}{2}$ in. scant for a total of 1 in. If a 2×10 and a 2×12 are used, the total depth will be $9\frac{1}{2} + 11\frac{1}{2} - 1\frac{5}{8}$ or $19\frac{3}{8}$ in. plus the $\frac{5}{8}$-in. plywood and slab thickness. The joint between the 2×10 and the 2×12 can be covered by a chamfer strip to add architectural interest; or the sides of deep beams can be made of plywood.

The size of lumber used in the beam sides establishes the depth of the joists supporting the slab forms. The whole wooden structure of the forms can thus be carried on a level table of 4×6's supported on shores. This saves untold dollars in cutting, measuring and leveling the work in place.

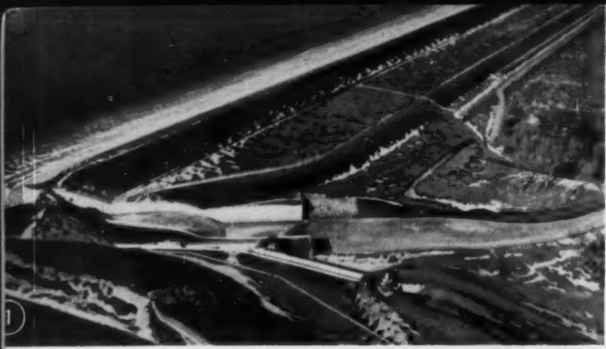
6. The structural design should be prepared simultaneously with the architectural design so that these items can be accomplished. Room sizes can usually be varied a few inches to accommodate the structural design.

In a school constructed by our firm the architect asked my cooperation to keep the cost down. After studying the preliminary sketches I suggested changing the classroom and corridor dimensions a few inches in length and breadth. He accepted the suggestions. The result was that the cost per square foot of the concrete structure was 25 percent less in 1956 than that of a similar school built ten years earlier in spite of a 40 percent increase in the construction cost index—a net saving of 46 percent.

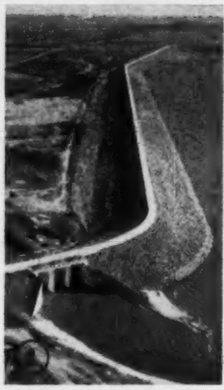
The procedure outlined can provide fireproof concrete construction at no greater cost than that of less desirable materials. A little tolerance is needed and a willingness to study the problems of others. This, with a lot of cooperation, can save money for the owner. The resulting structure will enhance the reputation of the consulting engineer as an economical designer. And the simplified forming will avoid a lot of headaches for the builder.

Water resources

PAUL H. BERG, A.M., ASCE, Project Manager



(1) Lovewell Dam



(2) Webster Dam
(3) Kirwin Dam

(4) Trenton Dam
(5) Cedar Bluff Dam
(6) Bonny Dam

(7) Enders Dam
(8) Medicine Creek Dam

(9) Typical Canal and irrigated area

Steady progress is being made in developing the Kansas River drainage area of the Missouri River Basin Project, authorized for construction by the Flood Control Acts of 1944 and 1946. Today, of the eleven dams authorized for construction by the Bureau of Reclamation, eight are complete: Medicine Creek, December 1949; Enders, January 1951; Bonny, May 1951; Cedar Bluff, October 1951; Trenton, November 1953; Kirwin, August 1955; Webster, June 1956; and Lovewell, September 1957. Irrigation water was delivered to the first lands on the Cambridge Unit in 1951. For the irrigation season of 1958, water was available for about 93,000 acres of land out of a water supply potential of 356,000 acres. Units essentially completed are: Cambridge, 15,600 acres; Franklin, 15,270 acres; Superior-Courtland, 8,970 acres; and Kirwin, 11,500 acres. Units partially completed are: Red Willow, 7,000 of 11,150 acres; Meeker-Driftwood, 8,600 of 16,440 acres; Frenchman, 9,600 of 21,090 acres; and Courtland, 16,400 of 49,000, Construction is just starting on the Webster, 8,500 acres. For the general location of dams and irrigation units see Fig. 1.

Development of water resources in the Kansas River drainage basin is part of the overall plan of development for the Missouri River Basin Project. This project envisions the conservation, control, and use of the basin's water resources through the cooperative efforts of federal, state and local governments. Its objective is to stabilize and increase agricultural and industrial productivity and to establish new economic opportunities. Major benefits from the project are irrigation, production of hydroelectric power, flood control, and navigation. Other benefits are municipal and industrial water supplies, new recreation facilities, fish and wildlife conservation, pollution abatement, and silt detention.

The Kansas River drainage basin is about 480 miles long, about 140 miles wide, and covers an area of 60,000 sq miles. The two main subbasins where principal Bureau construction has taken place are the Republican River, with a drainage area of 25,270 sq miles, and the

developed in Kansas River basin

A. D. SODERBERG, M. ASCE, Project Engineer, Bureau of Reclamation, McCook, Nebr.

Smoky Hill River, with a drainage area of 19,970 sq miles.

The basin as a whole constitutes about one-tenth of the drainage area of the Missouri River. The land rises from an elevation of 750 ft to about 5,500 ft at the western end of the basin. A noticeable break in the general slope occurs in the vicinity of Concordia, Kans., the slope west of that point being about 12 ft per mile, while that to the east is only about 5 ft per mile to the mouth. The climate varies from moderately humid, with an average rainfall of about 37 in., to semiarid in the western part, with an average rainfall of about 17 in.

The entire basin is subject to high winds, intense rainstorms and wide variations in temperature, extreme temperatures being 120 deg F at Alton, Kans., and −43 deg F at Holdrege, Nebr. The frost-free season ranges from approximately 150 days in the western part to 200 days in the eastern part. Agriculture and the processing of agricultural products constitute the principal industries in the basin. The uncertainty of adequate and timely precipitation greatly limits crop diversification in the western section of the basin. This coupled with long records of floods ranging from minor to disastrous made a natural combination for water resources development. Irrigation is not a cure-all nor does its practice guarantee bountiful crops; however, it assures consistent crop yields and permits greater diversification, thereby stabilizing the economy.

Dams and reservoirs form the backbone of the plan. Because of site and foundation considerations, all eight dams are of the earthfill type. Power development has not been found feasible for the dams constructed to date.

Range in size of the dams has not been great, the height above streambed varying from 91 to 134 ft, and that above foundation, from 93 to 202 ft. As may be expected, spillway discharges have varied considerably, from 35,000 cfs to 200,000 cfs, depending on the economics of spillway costs. This economic balance has been carefully analyzed to achieve the least expensive structure with all factors, such as relocations, inundation area, and evaporation, receiving consideration. A sedimentation pool for an accumulation of 100 years has been provided at each dam before encroachment on the conservation pool. Outlet capacities vary in accordance with stream demands and range from 150 to 4,100 cfs. Physical data on the dams and reservoirs are given in Table I.

In the formulation of the plans, reservoir hydrology furnishes the basic criteria for determining the size of dams. In reviewing this data one fact stands out—the extremely large variations in flow of individual streams in the basins. Flooding is frequent, and most streams show a number of floods for the periods of record. Many discharges vary from nothing to a maximum of 200,000 cfs. This fact is one of the very basic reasons for conserving and utilizing these waters and for decreasing the damage inherent in these floods. Inflow design floods were all based on actual storms transposed to the various drainage areas. For comparisons of the reservoir hydrology see Table II.

Any construction program of the magnitude of this one naturally invites attention to the costs involved. Certain relationships exist which are not only interesting but also may be of value in planning similar works in other areas. While not always consistent, the costs to conserve and control drainage areas show a pattern of $3,000 to $4,000 per sq mile for those in the 4,000-sq mile range up to about $8,000 per sq mile in the 1,000-sq mile range. As may be expected, relocation costs vary widely, ranging from less than one percent to 38 percent of the total costs. Dam embank-

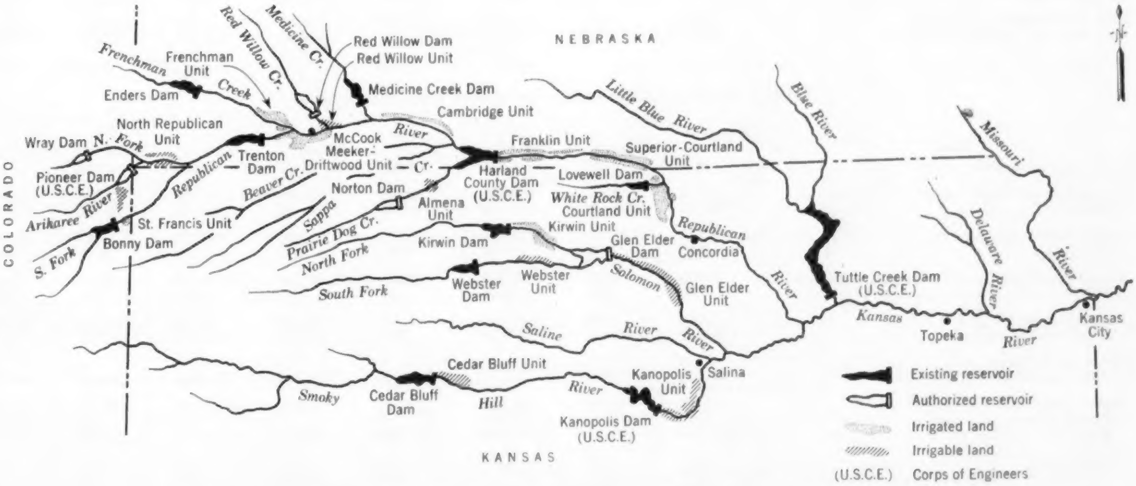


Fig. 1. Authorized projects of the Bureau of Reclamation in the Kansas River basin, here shown, are part of the overall plan for development of the Missouri River Basin Project.

ment costs per cubic yard show a consistent pattern downward, the first dam built being $1.03 per cu yd and the last $0.34 per cy yd, even though its volume was considerably less. Spillway costs per cubic foot per second of discharge vary from $15 to $31 per cfs. Relating all spillway costs to the cost of concrete shows a pattern that is fairly consistent, costs ranging from $62 to $100 per cu yd. Field costs and relationships are shown in Table III.

One of the problems connected with concrete construction in the Kansas-Nebraska area has been that natural aggregates found in the stream beds are reactive with cement. The reaction produces excessive expansion with resulting cracks and deterioration of the concrete. This expansion has been inhibited most effectively in laboratory tests by using a limestone coarse aggregate with the natural fine aggregates. To date, the only approved sources for concrete aggregate in this area are those located from 25 to 40 miles southeast of Omaha, near Kansas City, 100 miles south of Topeka, Kans., and 140 miles south of Manhattan, Kans. This restriction has increased the cost of the concrete aggregate from $1.00 to $2.00 per ton, but it is believed that the life of the structures is extended by several decades.

Another problem of construction in the area that deserves comment is the prevalence of loess soil and its use as a foundation material. True loess is a loose, wind-deposited soil covering a large part of the area. It is generally composed of uniform silt-sized particles which were loosely deposited and are bonded together with relatively small amounts of clay forming the typical loess "structure." Normally loess has high shearing resistance and will withstand high loadings without great settlement when the natural moisture content is low. However, when wet, the clay band tends to soften and cause collapse of the loess structure, inducing large settlement under low loading and loss of shearing strength. Undisturbed densities of true, wind-deposited loess normally range from about 75 to 85 lb per cu ft. If the material has been wetted and consolidated or has been reworked, the natural density is higher, sometimes as much as 100 lb per cu ft or more. In unusual cases, the wind-deposited material has been found to have a density as low as 65 lb per cu ft.

Studies by the Bureau of Reclamation have shown that the natural density is perhaps the most important index property of loess, in that the ultimate settlement that can be expected and the shearing resistance of the material after wetting are dependent largely on the natural density. The possibility of preconsolidating loess foundations has appealed to many engineers and designers, particularly for hydraulic structures such as dams, and where the materials will eventually become wetted.

In the case of earth dams, which exert a high pressure but are rather flexible, the theory indicated that by pond-

TABLE I. Physical data on dams and reservoirs

Item	Medicine Creek	Enders	Bonny	Cedar Bluff	Trenton	Kirwin	Webster	Lovewell
Dam								
Height above river bed, ft	115	103	128	134	100	117	107	91
Height above foundation, ft	165	134	158	202	144	169	154	93
Volume, cu yd:								
Earth & rockfill without spillway	2,730,000	1,951,000	8,853,000	8,490,000	8,130,000	9,537,000	8,145,000	3,000,000
Concr. in spillway & outlet	29,570	45,622	31,446	33,360	59,792	42,850	43,794	12,896
Crest length, ft	5,665	2,603	9,200	12,560	8,600	12,646	10,720	8,500
Crest width, ft	30	30	30	30	30	30	30	30
Base width, ft	840	670	980	910	800	960	940	680
Crest elevation, M.S.L.	2,415	3,137	3,742	2,198	2,793	1,779	1,944	1,616
Maximum spillway discharge, cfs	97,800	200,000	73,300	84,000	133,000	96,000	138,000	35,000
Outlet capacity, cfs	450	1,300	160	1,015	4,100	900	520	3,200
Freeboard, ft	6	8	6	6	8	6	6	6
Reservoir								
Dead storage, acre-ft	5,400	8,500	1,400	8,300	4,100	6,400	2,200	4,400
Sedimentation (100 yrs), acre-ft	30,000	4,000	16,000	26,000	102,000	18,500	13,000	16,000
Irrigation, acre-ft	33,800	36,000	39,900	176,800	116,100	88,800	64,900	37,300
Flood control, acre-ft	51,700	30,000	128,800	191,900	133,800	219,400	193,600	50,500
Surcharge, acre-ft	106,600	6,200	178,200	353,200	107,700	198,500	140,900	94,100
Area, top conservation pool, acres	1,768	1,707	2,042	6,869	4,970	4,940	3,445	3,001
Area, top max. water surface, acres	6,220	2,557	8,579	16,510	10,040	14,660	11,270	7,635

TABLE II. Hydrologic data on dams and reservoirs

Item	Medicine Creek	Enders	Bonny	Cedar Bluff	Trenton	Kirwin	Webster	Lovewell
Drainage area, sq miles	656	820	1,495	4,980	4,003	1,373	1,125	354
Average annual runoff, acre-ft	56,700	62,300	30,800	62,800	138,900	54,100	51,700	19,000
Period	'29–'56	'29–'56	'29–'55	'19–'56	'29–'56	'29–'56	'20–'55	'29–'49
Annual runoff, max., acre-ft	125,500	73,700	151,600	445,900	542,200	279,100	352,600	138,501
Year	1947	1949	1935	1951	1935	1951	1951	1950
Annual runoff, min., acre-ft	38,700	54,500	12,800	12,400	47,100	8,100	8,400	1,300
Year	1939	1939	1940	1954	1954	1956	1955	1934
Peak discharge, cfs	111,000	2,850	103,000	23,800	200,000	24,000	55,200	23,300
Date, mo. and year	6/1947	6/1940	5/1935	1951	5/1935	9/1919	7/1951	7/1950
Minimum discharge, cfs	6	5	0	0	0	0	0	0
Date, mo and year	1/1938	3/1938	Various	Various	Various	Various	Various	Various
Inflow design flood vol., acre-ft	300,000	300,000	409,000	810,000	396,000	607,000	436,000	254,000
Period, hours	72	84	72	192	72	144	84	336
Peak, cfs	200,000	200,000	245,000	391,000	295,000	260,000	268,900	82,000
Historical floods, years	1935 1942 1947 1948	1935 1940 1956	1935	1938 1951	1903 1915 1935 1936	1919 1950 1951 1957	1903 1915 1941 1948 1951 1957	1941 1947 1950 1951

ing, settlement could be attained during construction rather than later—after completion and filling of the reservoir. For this reason, for a number of dams in the area, where foundations on loess material were required, the foundations were thoroughly wetted by ponding and sprinkling before fill construction. It is significant to note that settlement measuring points established throughout these ponded areas showed very little settlement from saturation alone except in areas of very low density. An external load, applied by embankment construction or other means while the loess is wet, will cause consolidation.

Irrigation development

Irrigation development has followed a pattern of progress parallel with dam construction. Under Reclamation laws governing water, both rural and urban users are required to pay in accordance with their ability and the extent of their benefits. Revenue from main-stem power plants in the Missouri River basin will repay additional parts of the costs. Flood control and navigation allocations are non-reimbursable. Accordingly, repayment contracts have been signed with eight irrigation districts in this basin. Specific irrigation works for the districts are under way at the present time. Canal and lateral construction has been of conventional earth sections and has included the many varied irrigation structures, such as concrete siphons, wasteways, checks, turnouts, culverts, and bridges. Concrete pipe is used to a maximum, and precasting of the smaller irrigation structures is the dominant construction practice.

While irrigation conveyance and distribution systems do not have the glamour of dam construction, they have presented a real challenge since they must be economically fitted to the terrain and into existing ownership patterns. In this area of intense, intermittent rainfall, cross-drainage has been particularly vexing. A summary of physical data and some cost relationships is given in Table IV.

As funds become available, completion of the authorized dams of Norton, Red Willow, Glen Elder and Wray is contemplated, along with the associated irrigation units of St. Francis, North Republican, Almena, Glen Elder, Cedar Bluff and Kanopolis.

W. A. Dexheimer, M. ASCE, is Commissioner of the Bureau of Reclamation. Designs and technical supervision of construction are under the direction of Grant Bloodgood, M. ASCE, Assistant Commissioner and Chief Engineer, in Denver, Colo. The Kansas River Project is in the Bureau's Region 7, with R. J. Walter, Jr., Director.

TABLE III. Field costs and relationships for dams and reservoirs

(Includes right-of-way but excludes investigation, engineering and administration)

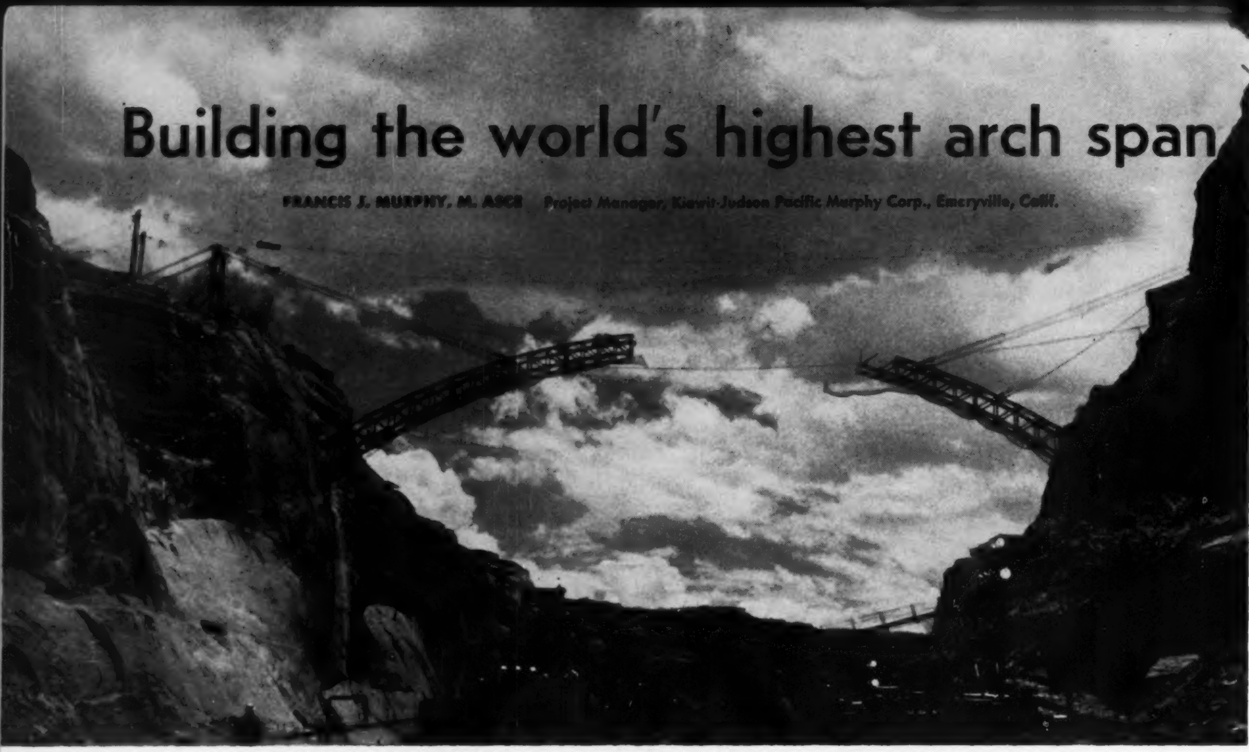
	Medicine Creek	Enders	Bonny	Cedar Bluff	Trenton	Kirwin	Webster	Lovewell
Years Built	1949	1951	1951	1951	1953	1955	1956	1957
Spillway	$1,947,000	$3,061,000	$2,309,000	$2,300,000	$3,298,000	$2,602,000	$2,451,000	$ 955,000
Outlet works	279,000	873,000	510,000	620,000	400,000	541,000	242,000	335,000
Relocations	209,000	159,000	139,000	105,000	6,887,000	1,352,000	671,000	740,000
Land and rights	431,000	557,000	255,000	685,000	767,000	1,689,000	1,263,000	1,225,000
Dam and dike structure	2,610,000	2,054,000	8,137,000	7,962,000	5,950,000	4,989,000	4,287,000	1,075,000
Clearing	86,000	18,000	20,000	12,000	64,000	39,000	24,000	55,000
Miscellaneous	127,000	89,000	153,000	120,000	743,000	52,000	349,000	123,000
Total	$5,689,000	$6,811,000	$11,523,000	$11,804,000	$18,109,000	$11,264,000	$9,287,000	$4,508,000
Spillway and outlet works, cost per cu yd of concr.	75	86	90	88	62	73	62	100
Spillway, cost per cfs of discharge	20	15	31	27	25	27	18	27
Outlet works, cost per cfs of discharge	620	670	3,190	610	100	600	470	100
Dam structure, cost per cu yd of embankment	0.96	1.03	0.92	0.94	0.73	0.52	0.53	0.34
Clearing, cost per acre, conserv. water surface	49	11	10	2	13	8	7	18
Rights-of-way, cost per acre, max. water surface	69	218	30	41	76	115	112	160
Relocations, percentage of total cost	3.67	2.33	1.21	0.89	38.03	12.00	7.23	16.41
Drainage area, cost per sq mile to control and conserve	8,670	8,310	7,710	2,370	4,520	8,200	8,260	12,730

TABLE IV. Data on irrigation units

	Meeker Driftwood	Red Willow (partial)	Cambridge	Franklin	Superior-Courtland (partial)	Sup.-Court. (partial) & Courtland	Kirwin
Years Built	1958	1954	1955	1956	1952	1958	1957
Physical data and relationships							
Acres per system	16,400	7,000	15,600	15,270	6,320	51,650	11,500
Miles	62.9	19.4	49.2	61.8	30.0	119.2	44.0
Lateral canal:							
Initial cap., cfs	284	130	325	308	139	751	175
Acres	6,450	2,150	3,200	2,770	1,500	10,790	3,600
Acres per mile	103	111	65	45	50	90	82
Miles	43.2	13.1	44.2	45.5	22.0	164.6	30.5
Capacities, cfs	4 to 30	6 to 18	6 to 30	6 to 24	6 to 18	6 to 42	4 to 24
Acres	9,950	4,850	12,400	12,500	4,820	40,860	7,900
Acres per mile	231	370	281	278	219	248	259
Acres per mile of system	155	215	167	142	123	182	154
Hydrology							
Consumptive use, acre-ft per acre	2.45	2.46	2.46	2.54	2.56	2.56	2.50
Effective precip., ft	1.40	1.45	1.50	1.53	1.60	1.60	1.53
Diversion req., acre-ft per acre	2.00	1.90	1.81	2.39	2.16	2.16	1.85
Field costs and relationships (Includes right-of-way but excludes investigation, engineering and administration)							
Canals	$4,136,000	$1,018,000	$4,050,000	$4,254,000	$1,426,000	$ 8,253,000	$2,432,000
Laterals	646,000	191,000	744,000	838,000	279,000	2,566,000	582,000
Rights-of-way	363,000	142,000	418,000	408,000	217,000	780,000	654,000
Total	$5,145,000	$1,351,000	$5,212,000	$5,500,000	$1,922,000	$11,599,000	$3,668,000
Canal cost per mile	65,800	51,600	82,500	68,900	47,500	69,200	56,400
Lateral cost per mile	15,000	14,600	16,800	18,400	12,700	15,600	19,100
Right-of-way cost per mile	3,420	4,370	4,470	3,800	4,170	2,750	8,780
System cost per acre	314	193	333	360	304	225	319

Building the world's highest arch span

FRANCIS J. MURPHY, M. ASCE   Project Manager, Kiewit-Judson Pacific Murphy Corp., Emeryville, Calif.



Cables hold the Glen Canyon arch of 1,028-ft span as it is built out from the sheer walls of the canyon, just downstream from the dam site. All photos courtesy U.S. Bureau of Reclamation.

The world's highest arch bridge is soon to be opened to traffic and the Colorado River will be spanned once more—this time by the highest steel arch bridge in the world. Of even greater significance is the fact that the completion of this 1,028-ft steel span will mark the termination of one of the first major contracts in the U. S. Bureau of Reclamation's Glen Canyon development. (See "Construction Begins on Glen Canyon Dam", by W. A. Dexheimer, M. ASCE, Civil Engineering, July 1957, vol. p. 473.)

Officially, the Glen Canyon Bridge is one of the initial segments of the contemplated Colorado River Storage Project embracing $760 million in funds for the Bureau of Reclamation's water development and power plants. Located about 140 miles upstream from the Grand Canyon, the Glen Canyon Dam site (Fig. 1) is 16 miles from Lees Ferry, Ariz., and 135 miles from Flagstaff, Ariz., the nearest railhead. The dam is scheduled for completion in 1964.

The Glen Canyon Bridge is one of the most interesting projects to be built in this country for some time. In addition to being the highest bridge of its type in the world, it was built in a completely isolated area. When the estimates were made for the job, the only access to the site was by private plane landing in the desert, or by an extremely difficult 75-mile overland trip in a four-wheel-drive jeep from Kanab, Utah.

FIG. 1. A 145-mile truck haul from Flagstaff over poor roads was one of the problems of building the bridge across Glen Canyon.

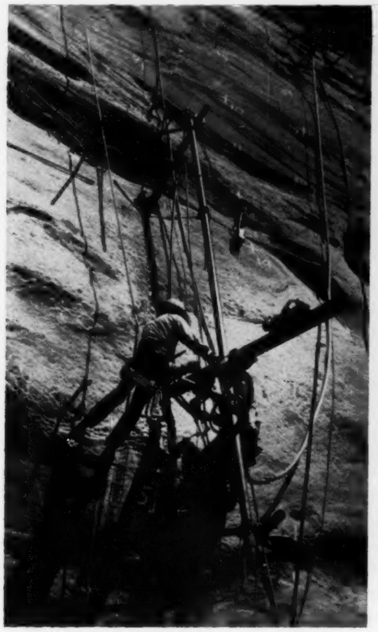
The joint-venture firm of Kiewit-Judson Pacific Murphy was the successful bidder on the Glen Canyon Project on December 19, 1956; the only other bidder was Bethlehem Pacific Coast Steel Corporation.

Over the deep canyon the steel obviously had to be erected from the top without falsework. Tiebacks to hold the arch during erection were a natural means of construction. And an overhead line or cableway was a logical means for the transport and erection of members as it greatly reduced the load that had to be supported on the erected steel over the deep canyon.

With this general plan for the work, construction started on a camp site and access roads into the area. Eight weeks were spent in minimum preliminary development of the site.

Foundation work

Foundations or skewbacks for the arch were installed some 500 ft above the surface of the Colorado River. Rock on the west side was found to be less dependable than anticipated and 9,500 cu yd were removed, requiring a larger skewback than had been planned and better ties into the rock.



Pneumatic drill, mounted on a quarry-bar, line drills holes along the excavation for the skewback.

Forms for placing concrete for the skewback were bolted to the nearly vertical rock wall of the canyon.

Accurately locating and placing the bridge base plates was a tough job for surveyors and bridgemen.

Getting a foothold on the nearly vertical canyon walls presented a problem. Workmen were supported in bosun's chairs, hazardous looking but as safe as other methods. Our own forces handled the surveying, establishing controls independent of the Bureau of Reclamation. Members of our surveying crew were exceptionally good high scalers, and what they could do on the cliff faces was phenomenal. While hanging by manila lines, they often took readings while the legs of their surveying instruments were inserted in crevices, supported on bars stuck into the cliff, or rested on tiny ledges.

Regular pneumatic drills were used but these were mounted on a quarry bar instead of being worked from a platform. The skewback periphery was line drilled, then blasted with light charges to avoid disturbing adjacent rock.

After excavation to the prescribed measurements, holes were drilled an additional 30 ft into the rock and anchor rods grouted in. Reinforcing was set and the skewback concreted with the main bridge base-plates or grillages in place. It was a critical operation, of course, to locate the base plates and anchor rods, for which surveying was done under most difficult conditions.

Steel fabrication

Fabrication of the steel started in October 1957 in the shops of the Judson Pacific-Murphy Corp. in Emeryville, Calif. Most of the members are built-up sections of angles and plates of structural carbon steel and structural alloy steel. Throughout the arch rivets were used, ranging in diameter from $1\frac{1}{8}$ in. down to $\frac{7}{8}$ in. The vertical posts, floor beams and stringers required normal fabrication, but the arch chord members had to be milled to a tolerance of 1/10,000th of an inch.

Before the steel was shipped to the job site, it was laid out on the ground and completely assembled in the form of four half-arches. In normal practice only three or four panels would be laid out and, as members were removed from one end, new members would be added to the other until the entire structure had been checked. However, on this job the dimensions were so critical, and it was so important to make sure that everything would go together smoothly at the site, that 21 panels were assembled (half the arch) before knocking down for shipment.

With the arch assembled on the ground, it was possible to introduce the proper rise and camber by taking physical measurements. When everything was found to be correct, the subpunched holes were reamed full size and the shop rivets installed. Open holes were left for field connections. Before shipment, the steel was sandblasted and given a shop coat of paint in Emeryville. All inaccessible steel surfaces received three coats of paint in the shop.

The fabricated steel was shipped 800 miles to Flagstaff by rail. Trucks and trailers hauled it the remaining 135 miles to the job site, where it was yarded in a storage area some 300 yd from the east end of the bridge.

Because the roads to the job site were not adequate for heavy trucking, the largest load carried was one of the four bottom-chord sections to be placed nearest the canyon walls. These sections weighed about 27 tons each. The longest member delivered was 54 ft.

Since a single cableway could not be considered adequate for construction in the single working season allowed for erection, two cableways were decided on. One cableway with fixed towers, a 1,500-ft span and a track cable of 2-in. diameter provided $12\frac{1}{2}$-ton capacity for the transport of personnel and light materials. This cableway ran beside the structure at a distance of 10 ft from it.

Main cableway for steel erection

The main cableway was located on the centerline of the bridge and used mainly for setting steel. The fact that the two trusses of the bridge are 40 ft apart presented a problem as it was necessary to shift the cableway so that it would be almost directly over each truss for ease in placing steel.

Two principal methods for horizontal movement were considered—traveling towers and tilting towers. The latter were chosen for economical reasons and they worked out extremely well.

Because of the different ground ele-

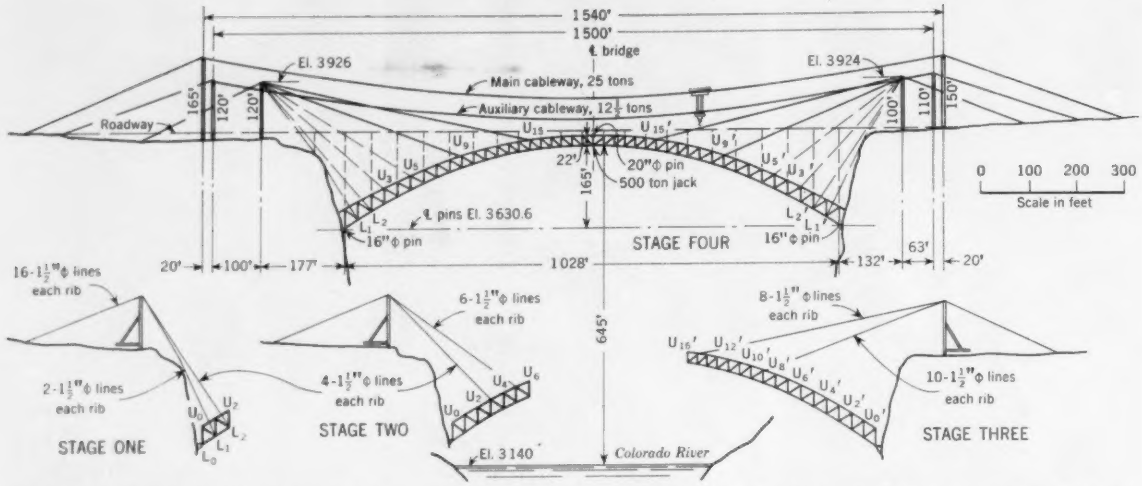


FIG. 2. Four stages of Glen Canyon Bridge construction are shown. First members L_0 L_1 were erected and held by two tie lines to L_1. All members were erected out to U_2 L_2 and held by four lines to L_2 for each rib. In second stage, erection continued out to U_6 L_6, and ties were placed at U_4; ties to L_1 and L_2 were removed. After erection to U_8 L_8, six ties were connected to U_6; the lines to U_4 were salvaged. Erection continued to U_{10} L_{10} with ten tiebacks placed at U_8; landward ties were removed. Additional members were placed to U_{16} L_{16} and eight ties at U_{16} adjusted to position the arch. These cables held the steel for completion of erection at a temporary pin at U_{21}. After closure and adjustment, riveted plates took over the center connection to make a two-hinged arch. Each of the supporting masts was tied back by 16 cables of 1½-in. diameter.

vations on each side of the canyon, one tower was 165 ft high and the other 150 ft. These towers were mounted on two pins at right angles to each other so that they could be tilted backward, forward, or to either side. They were luffed by means of side guys, the luffing being limited by fixed pennants adjusted to the maximum permissible movement.

The main cableway was designed for a 25-ton maximum load with a safety factor of three. The span, center to center of towers, was 1,540 ft. The hoisting speed was about 110 fpm and the lowering speed about 125 fpm. The carriage speed was 350 fpm. The head-tower, 165 ft high, weighed 35 tons and the tail-tower 32 tons.

The main track cable was a coil cable of 3-in. diameter, socketed as each end. When the hook was carrying a 25-ton load, the carriage was not run closer than 125 ft to either tower but could approach it with little or no load. The take-up for the track cable was 1⅜-in. regular lay cable, dead-ended to the top of the tail-tower. The cable passed through a series of sheaves forming a ten-part line, then back over a sheave on the tail-tower and down to base of the tower, where it was secured. A 92-ft sag of the main track cable was maintained within 2 percent by means of the take-up.

A two-drum, Superior-Lidgerwood-Mundy hoist of 250 hp was used for the main cableway. It was powered by a Waukesha diesel unit with a torque converter, hydraulic clutch controls, and manual brake controls. It had a line pull of 14,000 lb at 350 fpm with a 1,600-rpm maximum operating speed.

Tie-back system

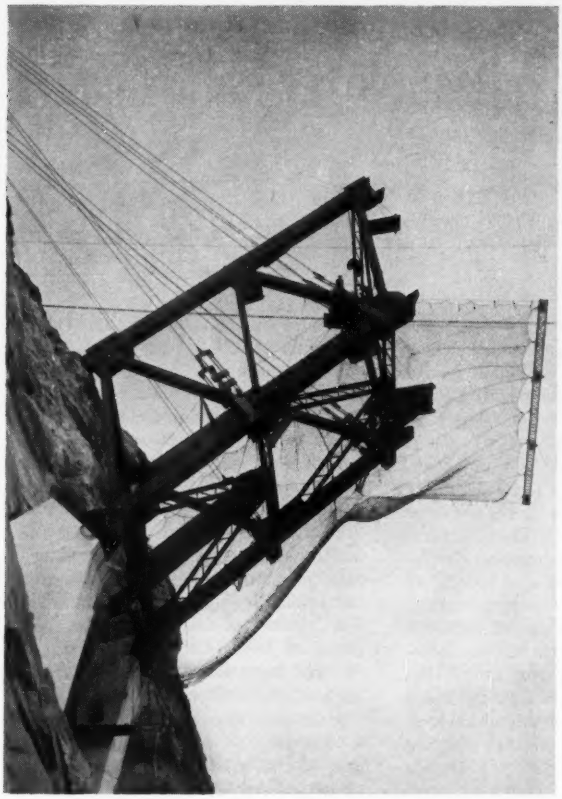
How the tie-back cables supported the arch during construction is shown in Fig. 2. A total of 48,340 ft of 1½-in. bridge strand was used for these cables. The maximum number of lines in use at any one time was 72. The most unusual feature of the tie-back system was the jacking arrangement, which permitted adjusting the length of the lines. Jacks were located between a pair of strong-backs at a point where the cables were attached to the arch in such a way that by expanding they would tension the cables.

By means of the jacks, the length of any two lines could be adjusted down to one-thousandth of an inch if necessary. The arch could thus be raised or lowered as required to make the final closure. These Watson-Stillman Co. hydraulic jacks of 110-ton capacity were used with water as fluid instead of oil to prevent the steel from becoming slippery in case the jacks should leak. Jacking was manual since close computation of deflections made it possible to preset the jacks so that little movement was required.

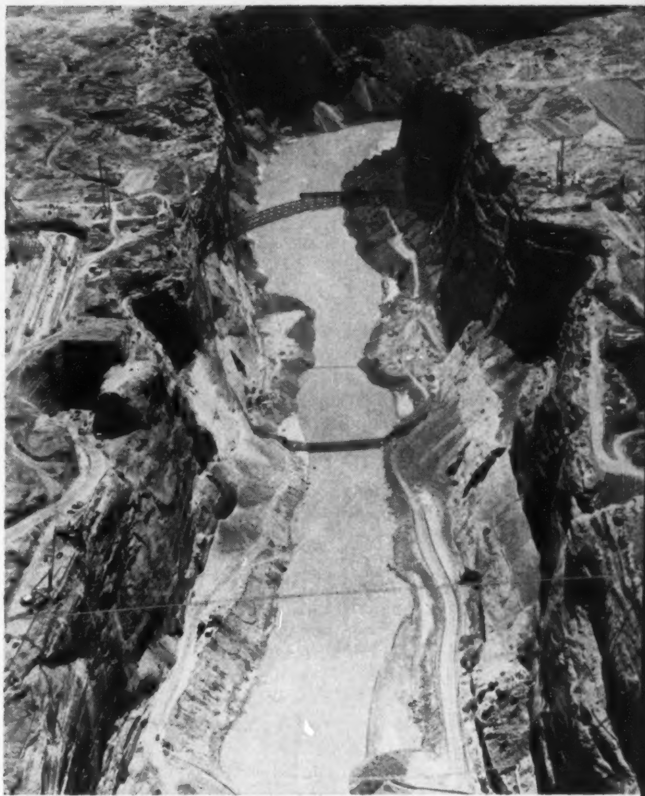
Jacks were used not only during the closure, but also to adjust the tie-back lines to equalize tension during erection operations. As erection proceeded, new tie-back cables were set in advanced positions and the previous ones released. The rear cables were extended in length and reused in a new position. The jacks were used to relieve the tension in the rear lines, thus transferring the load to the forward lines. The operation was carried on in such a way that it was seldom necessary to jack tension into a line, thus minimizing the work required.

Pressure on the jacks indicated that the actual loads in the tie-back cables never varied more than 5 percent from the theoretically computed loads. When the two half arches met in the middle and were pinned at the top chord, the tie-back cables were released and the entire arch was allowed to support itself. At this time it was, in effect, a three-hinged arch; that is, there were 16-in. pins at each skewback and a 20-in. pin at mid-span. However, the bridge was designed as a two-hinged arch with no hinge at the center. To lock the center hinge, which was used for simplifying the closure, jacks were placed in the lower chords at mid-span and a specified amount of load was jacked into the bottom chord. This load varied with the temperature and the live load that was on the bridge at the time. Shims were placed after the correct load was achieved and the bottom chord was drilled and riveted, after which the pin in the upper chord became inoperative.

With the arch completely erected and riveted, it was a comparatively simple matter to complete the deck system. The largest piece of steel placed in this section was a vertical column 162 ft long near the canyon walls. This col-



Steel erection starts on the west side of the river. Faulty rock required larger skewbacks than had been planned. The safety net saved three men from falling into the canyon.



Start of deck erection for the Glen Canyon Bridge. Cableways for bridge erection are held by the guyed masts. Traveling towers are for the dam construction cableways.

umn could have been built by placing a section at a time and making splices with the column in place. It was practical, however, to place the entire member, which weighed 29 tons, as a unit by using both of the cableways simultaneously.

The pickup points on the column were selected to keep the load properly distributed between the two cableways. The column was moved horizontally from the top of the canyon. Then, with a man stationed at the cliff edge giving signals to the hoist operators, the huge member was slowly tilted into a vertical position and set in place. For this operation it was necessary to luff the cableway towers to the maximum. This procedure proved most successful and was used for setting all of the large vertical columns.

Bolts for deck

The specifications permitted the use of high-strength bolts to connect the deck system of the bridge, and that method was employed. In tightening these bolts, the turn-of-nut method was used. This proved to be a fast and efficient procedure. (See article by M. H. Frincke, A.M. ASCE, Civil Engineering, Jan. 1958, vol. p. 31.)

Considerable study was also given to the forms for the deck concrete. Reuse of forms was deemed uneconomical because of delay in placing and completion. Stripping was dangerous on the high project and labor costly in this remote area. We decided to use "leave-in-place" steel forms for the deck and wood forms for the walkway, which could be stripped more easily. Concrete for the entire bridge deck was placed in twelve days using the main cableway.

The safety record for this job was remarkable. There were no fatalities and only a few lost-time injuries. An unusual safety precaution was the installation of protective tunnels of Armco corrugated steel pipe on each bank some 700 ft below the bridge. These tunnels permitted personnel to walk under the bridge without being exposed to the hazards of falling objects.

A safety net suspended from the arch at all times saved the lives of three men and undoubtedly speeded the work. It was a most gratifying experience to see a man emerge from the net having lost only five minutes of working time as compared to the probable loss of his life if the net had not been there.

Joint venture project

The joint-venturers for the project were Judson Pacific-Murphy Corp. of Emeryville, Calif., a subsidiary of Yuba Consolidated Industries, Inc., and Peter Kiewit Sons' Co. of Omaha, Nebr. The author, Francis J. Murphy, was the project manager and William A. Choate was the project superintendent.

Earl and Wright, Inc., of San Francisco, were the engineering consultants to the joint venturers. Under the direction of the project enginer, Alpo J. Tokola, J. M. ASCE, they developed the erection procedure. L. F. Wylie, M. ASCE, is project construction engineer for the Bureau of Reclamation on the Glen Canyon Project. The design of the bridge was performed under the supervision of Grand Bloodgood, M. ASCE, Assistant Commissioner and Chief Engineer, Denver. The dam is now being built under a $108 million contract held by Merritt-Chapman & Scott Corp. of New York, N. Y.

Stress analysis of a large radar antenna by digital computer

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In the past few years the civil engineering profession has become aware of the capabilities of high-speed electronic digital computers. At M.I.T. since 1952, the writers have had the opportunity to utilize various digital computers in connection with analytical structural research programs. One recent application of the IMB 704 computer which is expected to interest the practicing engineer is the analysis of the highly redundant three-dimensional framework shown in the accompanying photograph.

In this problem both the joint displacements and the bar stresses were required for several sets of loads. The time required to perform a rigorous analysis of the 3-D framework by conventional methods (without the aid of an electronic computer) would have been prohibitive on the basis of both calendar time and man hours. Indeed, the original designers of the structure, lacking time for experimentation with analysis by digital computer, utilized only approximate methods. One purpose of analysis of the antenna is to check results obtained by the approximate method. This paper is concerned principally with the implications of the computer technique. It is presented in the hope that other designers with similar structural problems will find something useful in the procedure.

The structure studied is a radar antenna having a height of 18 ft, a variable depth with a maximum of 13½ ft, and an overall length of 120 ft. The structural system consists of 319 members interconnected at 106 joints and having 12 reaction components. The members are so arranged that the external reactions are statically determinate but the structure is internally redundant to the 19th degree. The members are aluminum pipe sections and all joints are welded although in the analysis they are assumed to be pinned. The primary loads are dead load, ice load, and wind load.

An especially convenient, although not uncommon, feature of the structural arrangement, which is a prerequisite for the method of solution used, is the absence of members that connect joints in non-adjacent panels of the truss. The presence of this kind of member would necessitate a revision of the analytic procedure used.

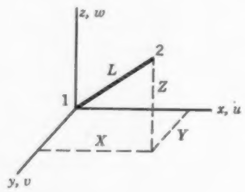
The structure was analyzed by the stiffness matrix method, which essentially involves writing the equations of force equilibrium for each coordinate direction at each joint in terms of the displacements of that joint and the adjacent joints.

In a 3-D structure with N joints (not including supports), this procedure leads to a set of $3N$ simultaneous equations in terms of $3N$ unknown displacements. The method of determining the coefficients of the stiffness matrix may be deduced from the equilibrium equations for a single member illustrated in Fig. 1. The six equations shown in the figure are expressions for the force components exerted by the member on the joints at its two ends in terms of the six joint displacements and the direction cosines α, β and γ. The stiffness matrix for this member is the 6 x 6 matrix of the coefficients of the displacements on the right side of the equations. The complete joint equations are obtained by adding and equating to zero (or the external load) the expressions for the forces exerted in each coordinate direction by all the members at the joint.

For the antenna framework, the stiffness matrix is a 300 x 300 square matrix (since there are 300 unknown displacements) which involves 90,000 coefficients, many of which are zero. However, the primary memory of the IBM 704 utilized in this investigation has room for only 8,192 words. This insufficiency of storage space in primary memory is a common difficulty encountered in the use of computers. A more serious difficulty than memory space is computing time. Although the IBM 704 is capable of 40,000 operations per second, a 300 x 300 matrix if solved directly would require excessive machine time. For these two reasons it is necessary to develop a modification of procedures commonly used in manipulating matrices.

The structural geometry is such that the stiffness matrix for the antenna is amenable to arrangement in submatrices each of which is small enough to be handled by the computer. The method of elimination is used on each submatrix

L = length
AE = member stiffness
$\alpha = X/L$
$\beta = Y/L$
$\gamma = Z/L$
u, v, w = joint displacements
F = force components



Force components for the pin-ended member shown above are computed as follow:

$$F_{1x} = \frac{AE}{L}\left(\alpha^2 u_2 + \alpha\beta v_2 + \alpha\gamma w_2 - \alpha^2 u_1 - \alpha\beta v_1 - \alpha\gamma w_1\right)$$

$$F_{1y} = \frac{AE}{L}\left(\alpha\beta u_2 + \beta^2 v_2 + \beta\gamma w_2 - \alpha\beta u_1 - \beta^2 v_1 - \beta\gamma w_1\right)$$

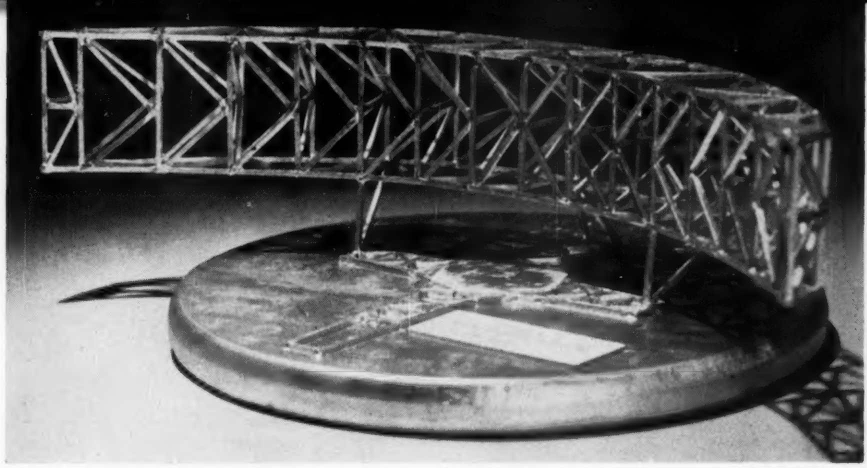
$$F_{1z} = \frac{AE}{L}\left(\alpha\gamma u_2 + \beta\gamma v_2 + \gamma^2 w_2 - \alpha\gamma u_1 - \beta\gamma v_1 - \gamma^2 w_1\right)$$

$$F_{2x} = \frac{AE}{L}\left(-\alpha^2 u_2 - \alpha\beta v_2 - \alpha\gamma w_2 + \alpha^2 u_1 + \alpha\beta v_1 + \alpha\gamma w_1\right)$$

$$F_{2y} = \frac{AE}{L}\left(-\alpha\beta u_2 - \beta^2 v_2 - \beta\gamma w_2 + \alpha\beta u_1 + \beta^2 v_1 + \beta\gamma w_1\right)$$

$$F_{2z} = \frac{AE}{L}\left(-\alpha\gamma u_2 - \beta\gamma v_2 - \gamma^2 w_2 + \alpha\gamma u_1 + \beta\gamma v_1 + \gamma^2 w_1\right)$$

FIG. 1. Stiffness matrix is developed for a pin-ended member



Model indicates three-dimensional framework of the radar antenna for which a computer program is described here. Analysis of the highly redundant 3-D framework was performed with the aid of an IBM 704 computer.

in succession with the back substitution deferred until the last submatrix. Of the 90,000 coefficients in the matrix, only about 7,000 are non-zero and these are grouped along one diagonal of the matrix. The significance of this fact is illustrated by Fig. 2, which shows the matrix for a similar but smaller structure. All the non-zero terms are contained in the submatrices *I, II, III* and *IV*. The overlapping squares *a*, *b*, and *c*, are smaller submatrices which are common to adjacent larger submatrices.

Since each submatrix is concerned only with a discrete number of unknowns, it is possible to operate on each submatrix independently, thus reducing the time and space required to reasonable proportions. Starting with the stiffness matrix and the external truss loading stored on tape, and with the stiffness matrix arranged as a sequence of submatrices *I, II, III* and *IV* (Fig. 2), the procedure is as follows:

First, submatrix *I* is read into primary memory and the elimination procedure is performed on those unknowns which are not common to the next adjacent submatrix. Thus if submatrix *I* is a 12 x 12 and submatrix *a* a 4 x 4, elimination is performed on only the first 8 unknowns.

The modified submatrix I' is stored back on tape and the second submatrix *II* is brought in from tape. The modified lower-right-corner submatrix a' in I' is stored over the *a* submatrix in the upper left corner in submatrix *II*. Elimination is then performed on all unknowns in submatrix *II* except those that are related to submatrix *b*. This procedure is repeated until the elimination is complete for the entire matrix. At this stage in the computation the back substitution portion of the method is applied to each successive matrix in turn but in reverse order starting with modified submatrix IV'. The resulting answers are joint displacements. For the subject truss the largest individual submatrix is a 45 x 45 and the typical submatrix is 36 x 36. The 300 x 300 matrix is subdivided into 14 submatrices.

When all the joint displacements have been determined, the bar stresses are obtained by a short independent program. This is simply an evaluation of the equation for bar stress,

$$F = \frac{\mathrm{AE}}{\mathrm{L}} \Big[\alpha\,(u_2 - u_1) + \beta\,(v_2 - v_1) + \gamma\,(w_2 - w_1) \Big]$$

in which the notation is the same as in Fig. 1.

One of the basic difficulties in using a digital computer to solve problems of this type for which a solution by any other technique would be impracticable, is the necessity for developing some kind of check on the computations. In this case, a simpler hand-computable trial problem was established having the same basic characteristics as the principal problem. The preliminary programming and testing was performed on this smaller problem and in this way the correctness of the general procedure was verified. In addition, equilibrium checks were made using the bar stresses obtained in the final solution of the real problem. These consisted of testing the equilibrium of the external loads and also the equilibrium of the stresses in bars cut by various planes through the structure and the loads to one side of such planes. These checks indicated that the maximum error in bar stresses was less than 10 lb in bars having stresses of several thousand pounds.

The computer program developed for this problem can be utilized on the IBM 704 to solve any size of planar or three-dimensional truss having the geometric characteristic specified above. The stiffness matrix was hand-calculated in this study and would be required input data for the present program. However, a procedure is being prepared that will permit the computer to calculate and store the stiffness matrix from a list of joint coordinates and member sizes. This is highly desirable because hand-calculation of the stiffness matrix in this problem required about 15 man days.

The procedure is also capable of handling a large number of loading cases simultaneously without taxing the computer memory. In addition, it is a very simple procedure to introduce the effects of changes in truss member sizes on the indeterminate analysis because the stiffness matrix is only affected locally. Thus the design process can be speeded up immeasurably. In the subject problem one complete solution for one loading is obtained in 10 minutes. Each additional loading case adds approximately 4 minutes to the computer time.

The analysis described above is one more example of the value of computers in the design of complex structures. Not only is a rigorous rather than an approximate solution obtained but the actual time required is less than that required for the approximate solution using ordinary computing devices. The procedure described above also indicates the importance of investigating a variety of possible solution methods. Instead of a solution time of 10 minutes, one available program would have required approximately 14 machine hours to solve this problem. Another program would have required approximately 90 minutes.

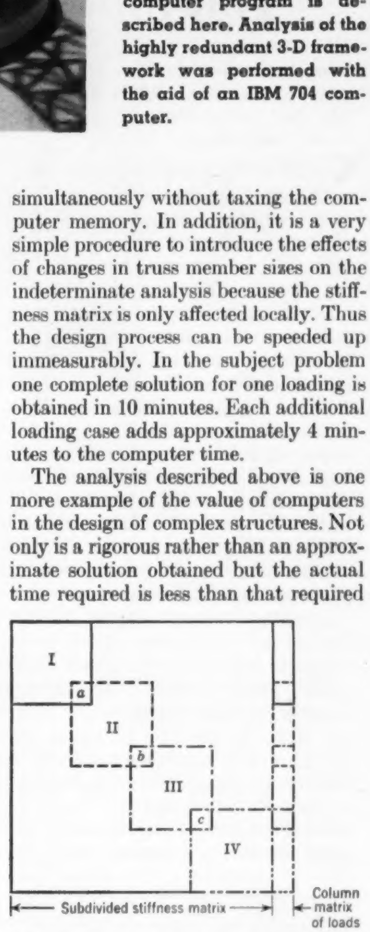


FIG. 2. Partitioning of augmented stiffness matrix for a similar but smaller structure gives four submatrices with smaller submatrices common to each.

The work reported here was performed by the writers as consultants to Lincoln Laboratory, which is supported by the Army, Navy, and Air Force under contract with the Massachusetts Institute of Technology.

OAHE DAM CLOSURE—

Another shackle on the Missouri River

DAVID G. HAMMOND, M. ASCE, Colonel, Corps of Engineers, U. S. Army; District Engineer, Omaha, Nebr.

Closure of the Army Engineers' mammoth Oahe Dam, on the Missouri River six miles upstream from Pierre, S. Dak., was completed at 3:35 a.m., Aug. 3, 1958. The feat of literally choking off the Missouri River and diverting a 9,000-cfs inflow into storage behind the dam was accomplished after a 21½-hour struggle in which man was pitted against the river. The method of closure was unusual in that a difficult diversion was accomplished as a routine-appearing operation made possible by a huge fleet of earthmovers and an abundance of Pierre shale, the bedrock common to the area. Electronic computers were used to determine the optimum channel size, required equipment capacities, and speed of closure.

Any story dealing with the construction of the Oahe project would be incomplete without a description of the overall project, which is king-sized in every way. When completed, Oahe will lay claim to the title of the world's largest rolled earth dam. It will be 9,300 ft long and 242 ft high, and will contain 90 million cu yd of earth and shale. Push-button control over a subdued Missouri is furnished by six massive outlet tunnels in the right (facing downstream) abutment. In addition to these huge tubes, each one capable of holding a freight train, the dam will be pierced in the left abutment by seven power tunnels each 24 ft in diameter, leading to a 595,000-kw hydroelectric plant, the largest on the Missouri River.

One mile landward from the right abutment the dam will be served by a gated spillway 456 ft long at the crest and capable of carrying 300,000 cfs. The outlet works (completed), spillway and power facilities (under construction) will require about one million cu yd of concrete.

Behind the Oahe embankment, the Missouri River will form a 250-mile reservoir which, at full pool, will cover 376,000 acres and contain 23,600,000 acre-ft of water. The headwaters of this huge impoundment will extend to a point about five miles down river from Bismarck, N. Dak.

Oahe, 1124.3 miles above the mouth of the Missouri River, is situated between two companion Missouri River dams, now in operation. See map, Fig. 1. Garrison Dam in North Dakota is 331 miles upstream from Oahe. Some 200 miles down river, Fort Randall Dam exercises multiple control over the once wild Missouri. Other Missouri River dams include Fort Peck in eastern Montana and Gavins Point at the Nebraska and South Dakota border near Yankton, S. Dak.

Construction of the sixth and final link in the chain of these multiple-purpose projects, Big Bend Dam, is scheduled to start in 1959.

Teaming up to make the Missouri River a servant instead of a master, these big dams also came in handy during the construction phase, giving big assists in water control while one of the earth links was being forged elsewhere on the main stem. Such was the role of Garrison and Fort Randall Dams during the Oahe closure.

Garrison provided a means of regulating the flow at Oahe to a minimum during diversion. Towns between Garrison and Oahe relying upon the Missouri to provide water for domestic supplies and for sewage disposal required a minimum of 6,000 cfs from Garrison.

Studies of stream flow records showed that the uncontrolled tributaries below Garrison could be ex-

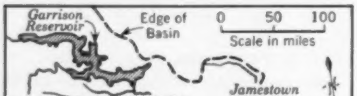


FIG. 1. Oahe Dam is the newest of five major structures on the Missouri. Big Bend Dam is scheduled for start of construction this year.

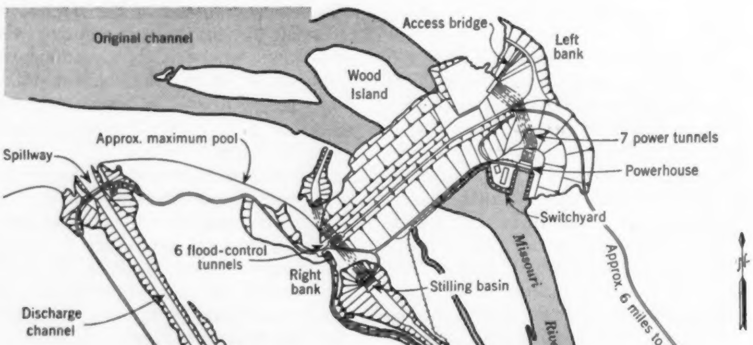


FIG. 2. Plan of Oahe Dam on the Missouri River.

Oahe Dam near the end of the 1958 construction season. The several features of the permanent structure are shown in white.

pected to contribute an additional 1,000 to 4,000 cfs. With this in mind, the diversion operation was planned for inflows to Oahe of from 7,000 to 10,000 cfs. Meanwhile, Fort Randall Reservoir downstream had been filled to 4,460,000 acre-ft to guarantee a flow of 30,000 cfs required for navigation and other needs in the river below Omaha, Nebr., in addition to meeting the summer's heavy power demand.

Early in the design stage it became evident that the best results from the standpoint of economy in construction and a more stable abutment would be realized if the outlet tunnels, of 19-ft 9-in. diameter, were set as high as possible. The tunnel portals at both ends are in deep shale excavations (Fig. 2); thus the higher the setting the shorter the tunnels; the less the excavation, the more stable the slopes. The invert of the riverward, and lowest, of the six outlet tunnels is at El. 1425, which is about the river stage for the normal summer flow of 30,000 cfs. The inverts of the remaining tunnels are set progressively 6 ft higher, the landward tunnel invert being at El. 1455, or 30 ft above the normal river surface.

A reservoir elevation of 1445 is required to pass a discharge of 7,000 cfs through the tunnels; this is a head differential of 25 ft above the tailwater elevation for that discharge. The head differential for 10,000 cfs is 28 ft. With heads of this magnitude required for discharging the river flow, it was evident that little dependence could be placed on tunnel capacity, at least during the early phases of any diversion scheme. Ultimate success must depend on maintaining a steadily rising pool, by diverting the inflow into storage.

The basic problem was how to build the needed head in the contracted channel at the dam site starting with a river discharge of 7,000 to 10,000 cfs. The head build-up had to be steady and swift enough so that the rate of storage accumulation in the pool upstream eventually would equal the river inflow. Many plans were studied. Among them was the placing of rock-filled timber cribs across the river channel, dumping heavy, hard rock or shale into the channel from a bridge or trestle especially built for the purpose, and blasting large stockpiles of shale from the banks into the river channel. These plans and others were discarded because of high costs or uncertainty of performance.

When construction of Oahe Dam was started in 1950, the Missouri River was a mile wide between its banks. In mid-channel lay Wood Island, a high wooded sand bar about a half mile wide. The whole flood plain is covered with a 70-ft thickness of alluvium (fine sand and silt) over shale bedrock.

In the spring of 1952 the channel to the left, or east, side of Wood Island was blocked by a low-level shale barrier. The west side of Wood Island was armored with 60,000 cu yd of dumped shale for bank protection to stabilize what was now the left bank of the remaining 1,700-ft width of river channel. Later in 1952 the channel was narrowed to 1,050 ft by extending the embankment into the river from the right bank. In the fall of 1953 the channel was again narrowed, this time to 650 ft, by additional embankment construction, encroaching from the right bank.

This width was considered to be the minimum that would pass flood flows without serious erosion of the banks. Material lost either from the end of the embankment or from Wood Island would have to be replaced by pay dirt. The river remained 650 ft wide until the 1958 construction season, although embankment construction was continuous under five separate earthwork contracts, on one or both banks of the river from the start of construction in 1950.

The plan selected for closure was a natural one for the specific conditions that prevailed at Oahe. To illustrate, the embankment base is 3,700 ft between the upstream and downstream toes. Starting at the upstream toe and extending 1,000 ft downstream, the base of the embankment below the river surface is built of dumped shale. The downstream portion is similar except that the dumped shale extends only 600 ft. See Fig. 3.

Normal earthwork construction at Oahe requires a rate of excavation and placement of at least 2,500 cu yd per hour. Sampling of shale at random from required excavations showed gradations ranging from silt to the 6-ft size. Average samples had 50 percent of the material by weight finer and coarser than the 15-in. size.

Why then couldn't the river be stopped by rapid dumping of shale into the channel within the normal dumped shale zones of the embankment? Initial studies showed that it could be stopped by rapid and continuous narrowing of the channel until it was choked off at heads well below the 25 to 28 ft required to divert the full inflow through

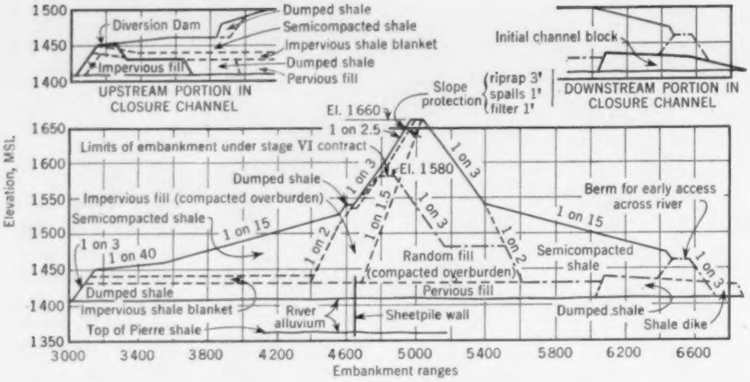


FIG. 3. Typical valley section of Oahe Dam embankment. Scale is distorted 4 vertical to 1 horizontal. The semicompacted zones are made more massive near the abutments.

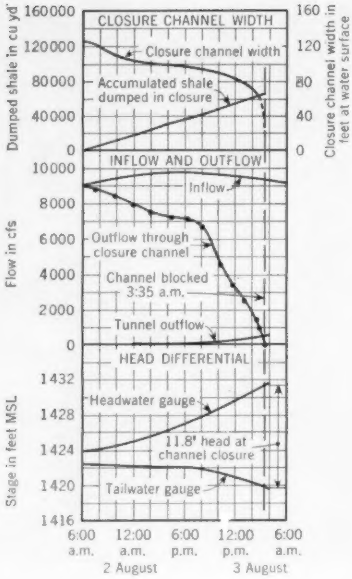


FIG. 4. Dumped material closed the channel, reduced the flow, and increased the head differential at Oahe Dam site during a dramatic 24-hour period last August.→

the permanent diversion tunnels.

The upstream shale zone was better for closure than the downstream one because the necessary length to develop the head would be available. Also, at this location it was planned to build the diversion dam, part of the ultimate embankment, to divert flows through the tunnels. However, for initial closure the upstream zone was abandoned in favor of the downstream zone, because the high velocity through the ever narrowing channel would carry shale into the central zone of the embankment, an objectionable material in that area. As the downstream berm lacked length, it would be necessary to add a 300-ft shale dike downstream to confine the flow. After initial shutoff was accomplished at the downstream location, earthmoving operations would immediately be shifted upstream for the building of the diversion dam.

Electronic computer used

The initial hydraulic analysis, which demonstrated the feasibility of the closure plan, was implemented by a large number of computations made with the assistance of an electronic computer. Constant values of inflow, length of diversion channel, and rate of dumping rock over the channel banks were assumed. Computations were made for successive short time intervals. The head rise during each interval increased the reservoir storage. The rate of storage increase and the tunnel outflow, if any, were subtracted from the inflow to give the outflow through the diversion channel.

The headwater and tailwater elevations determined the slope in the diversion channel which, together with the discharge, defined the transport rate of rock out of the downstream end of the fill. The difference between the volume dumped and the volume transported out increased the fill, causing the headwater to rise.

The phenomena just described are closely interacting, and their analytical solution required a lengthy series of trial-and-error calculations. This could best be performed by an electronic digital computer of the stored-program type, utilizing 2000 storage locations. The computer reduced to five minutes a diversion calculation that would have required two days by hand. In all, 120 different diversions were computed.

Using the computer results for a certain combination of inflow, diversion channel length and dumping rate, it was possible to plot time against discharge, headwater, tailwater, channel width, volume accumulation in the fill, and the transport rate. Among other principal parameters studied were rock size, hydraulic roughness, and shape of the channel cross-section. Computations over a wide range of possible conditions verified the assumption that diversion was entirely feasible for inflows from 7,000 to 10,000 cfs, for a diversion channel length of 600 to 1,000 ft, and for a rock dumping rate of 2,500 cu yd per hour.

Diversion and closure in earthwork contract

The closure was part of the contract for building the sixth stage of the Oahe embankment, awarded November 11, 1957. Over 24,000,000 cu yd of excavation (shale and overburden in three unclassified bid items) are included in the contract, which has a scheduled completion date of February 29, 1960. Since the work in connection with diversion and closure is a normal required earthwork operation, no special payment item was provided. Payment was made under the unit prices for excavation and fill. Since the plans were fully detailed by the Government, the contractor was not required to prepare a plan of his own.

At the time this earthwork job was advertised, it was uncertain whether outlet works would be ready for diversion in mid-summer 1958. In the event that diversion had to be postponed until the spring of 1959, continuing work was scheduled for the contractor in the spillway area, where 7,600,000 cu yd of excavation was included in the contract.

Closure effected

The first encroachment of the embankment on the river in 1958 was made as planned, narrowing the gap from 650 ft to 350 ft. River flows varied from 15,000 to 30,000 cfs. Early in the construction season an ice jam occurred downstream from the dam. The resulting backwater overtopped by 10 ft the fill that was already in the river. Construction was suspended for several days and some fill material was lost when the backwater was released after the ice jam broke. The first encroachment portion of the embankment was raised to El. 1500 by July.

By June it was determined that closure could be made in 1958 and the

contractor was advised to proceed accordingly. On July 7 the second encroachment was started, narrowing the river from 350 ft to 125 ft (except in the central part of the embankment) at the rate of 25 ft per day. Meanwhile, river flows through the gap were reduced from 29,000 cfs to 15,000 cfs by regulating releases from Garrison Dam upstream. The second encroachment portion was raised to El. 1490 in July. The channel was maintained at the 125 ft width until construction of the initial channel block was started.

At 6:00 a.m. on Aug. 2 construction of the initial channel block was started. At the start, the river was racing through the gap at 9,000 cfs and was predicted to crest at 9,500 cfs on Aug. 3. The rise was due to a 2-in. rainfall in the tributary Cheyenne River basin upstream.

The contractor's earthmoving fleet included two 12-cu yd shovels and one 14-cu yd dragline for excavating shale. Fourteen 29-cu yd bottom-dump and twenty-three 38-cu yd end-dump trucks hauled the shale about two miles from the excavation source to the channel block. Four D-9 dozers worked at the channel block pushing shale over the bank. Across the gap four other D-9 dozers waited with engines idling, to shove the stockpiled shale overbank to control any bank erosion that might develop.

At the start the equipment dumped along the full 900-ft length, continuing until 7:00 p.m. After that dumping was confined to the upstream 600 ft.

Cutting of the left bank was minor until about noon, when it began to increase. Some of the stockpiled shale on the left bank was dozed into the gap between noon and 1:00 p.m. During this operation the right bank receded slightly even with continued dumping.

As the left bank was cut back, chunks of the shale stockpile tumbled into the river. Therefore the bank was in effect self-healed until velocities again increased. Left-bank cutting varied from 10 to 40 ft along its length during the period when the initial channel block was being constructed. From 6:00 to 8:00 p.m. little gain was made in advancing the right bank into the channel. After that the channel narrowed constantly until dozers from the left and right banks finally bumped each other at 3:35 a.m. on Aug. 3—culminating a 21½-hour battle of men and machines with the Missouri River.

The results of hydraulic measurements and other data obtained during diversion are plotted in Fig. 4. The hump in the closure channel outflow hydrograph and the slow progress in narrowing the width between noon and midnight on Aug. 2 is explained by an increase in inflow during the same period. The rapid decrease in width and closure channel outflow after about 2:00 a.m. on Aug. 3 coincided with a gradual deviation from the original scheme of dumping shale over the entire 600-ft bank line by concentrating dumping at the upstream end. When the river was blocked at 3:35 a.m., the head differential was 11.8 ft and the outflow through the tunnel was only 450 cfs. The curve of accumulated dumped shale appears as a straight line, indicating a reasonably steady dumping rate of about 3,100 cu yd per hr throughout the operation.

Only 2,500 cu yd per hour were required to be placed under the terms of the contract. Some 67,000 cu yd of shale were dumped or dozed from the right bank of the closure channel. In addition, an estimated 24,000 cu yd were eroded from the left bank as the bank line receded an average of 25 ft. About 2,000 cu yd were dozed from the left-bank berm. Of a total of about 93,000 cu yd either placed or eroded into the channel, about 6,000 cu yd were transported out and deposited downstream of the closure channel.

Meanwhile preparations were being made for constructing the upstream diversion dam. By 3:07 a.m. it was evident that the four dozers on the left bank would not be needed at the stockpile so they headed upstream. As soon as the initial channel block was made, the great fleet of trucks joined the dozers to raise the diversion dam as quickly as possible ahead of the rising pool. Just enough shale was dumped on the downstream initial channel block to hold the rising pool until the diversion dam took over at about 10:00 a.m. A ditch was cut through the initial channel block to drain the water trapped in the central dam section.

Shortly after diversion, shale and earth were placed in the upstream part of the dam at a rate of 50,000 cu yd per day. Production was later increased to 100,000 cu yd per day as working space was added, raising the dam to El. 1580 (170 ft above the river). By the end of the 1958 construction season, over 10,000,000 cu yd had been placed in the embankment after the river was blocked on Aug. 3, and the contract was completed about one year ahead of schedule.

Western Contracting Corporation, Sioux City, Iowa, is the contractor for Earthwork Stage VI. Carl "Rip" Collins is project manager for Western. John Sibert, Jr., is Area Engineer at Oahe for the U. S. Army Engineer District, Omaha. J. O. Ackerman, M. ASCE, Chief, Engineering Division, directed planning of the Oahe diversion and closure.

The Missouri River had been narrowed to 125 ft when final closure started on the morning of Aug. 2. Stockpiled material was bulldozed in from the opposite bank to control erosion.

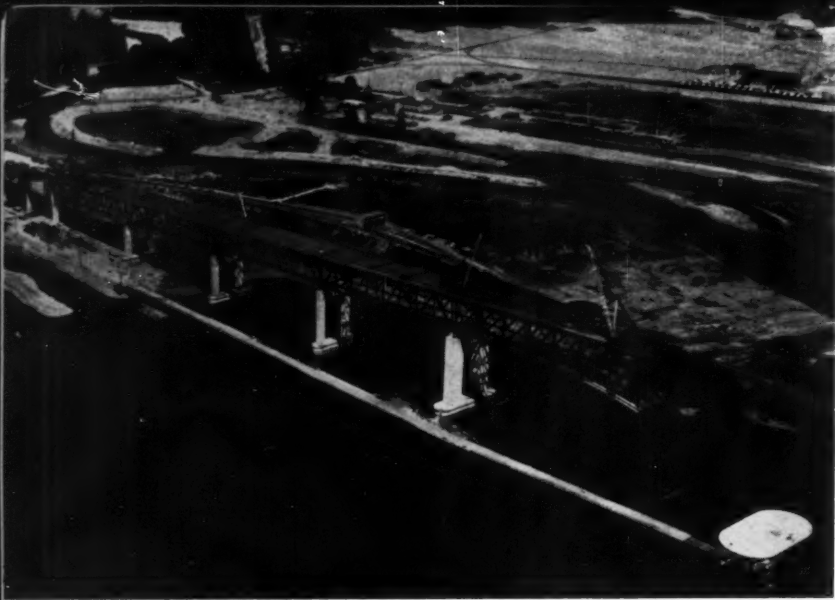
Dumping continued unabated during the night. Soon after this photo was taken, Oahe Dam started to control the flow of the Missouri River.

The six huge intake structures upstream channel water under the control works in the foreground.

Discharge of the controlled Missouri River in the fall of 1958.

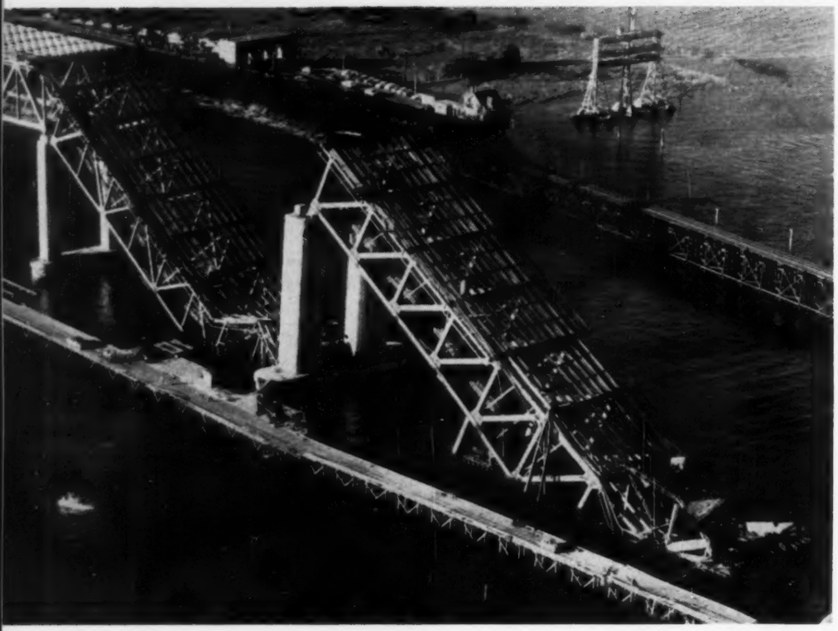
Findings on

F. M. Masters, M. ASCE, Partner



Aerial view taken two days before the collapse of the structure. Erection had advanced only a little beyond that shown. Note the falsework at Panel Point 4 and support for it below Panel Point 8.

Detail of temporary support at Panel Point 4. The transverse grillage, which served also as a cross strut, is blamed for the failure.



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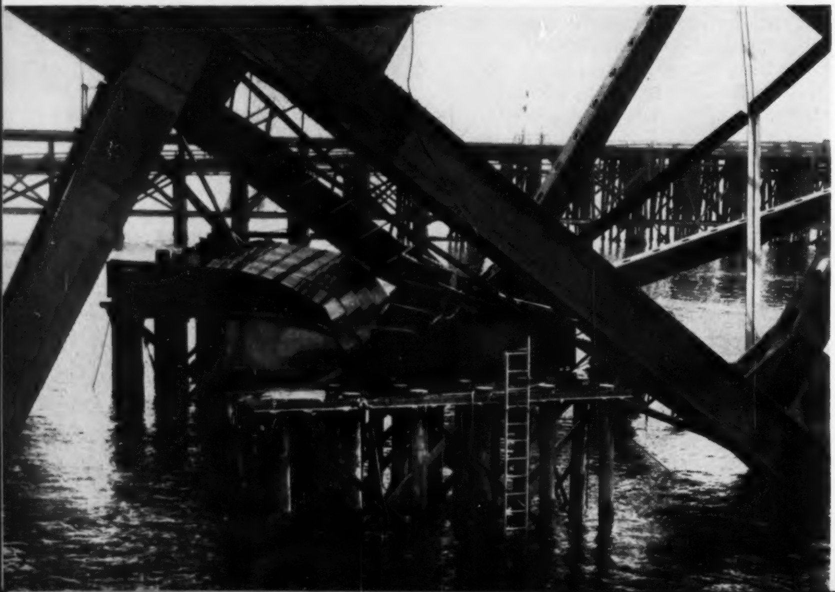
Many workmen and two derricks rode the two spans down. The failure of the grillage and dropping of the tied-down outer span had sufficient force to fracture the pier columns, permitting the pier to move out from under the expansion rocker of the next span.



The pile support for falsework Bent N4 was practically intact after the structure fell. It will be reused to complete erection.

Second Narrows Bridge collapse at Vancouver

Modjeski & Masters, Harrisburg, Pa.   J. R. GIESE, M. ASCE, Partner, Modjeski & Masters, Harrisburg, Pa.

On June 17, 1958, two spans of the $16,000,000 Second Narrows Bridge, a six-lane highway bridge under construction at Vancouver, B. C., collapsed when the grillage beams at the base of a falsework bent supporting the anchor arm suddenly gave way, and the anchor span and an adjacent span fell into Burrard Inlet.

His Honor, Lt. Governor Frank McKenzie Ross, immediately began an inquiry. Acting under the terms of the Public Inquiries Act, on the following day he appointed the Hon. Chief Justice Sherwood Lett of the Supreme Court of British Columbia, as sole Commissioner of a Royal Commission to inquire into the cause of the collapse and any and all circumstances connected with it. The Commissioner appointed John L. Farris, Q. C., as Commission Counsel, assisted by W. J. Wallace, and named Robert Wilson as Secretary of the Commission.

A staff of engineering advisers was appointed consisting of J. R. H. Otter of Rendel, Palmer and Tritton, and Ralph Freeman, M. ASCE, of Freeman, Fox and Partners, both of London, England; Dr. F. M. Masters, M. ASCE, and J. R. Giese, M. ASCE, of Modjeski and Masters, Harrisburg, Pa., and A. B. Sanderson of Victoria, B. C., associate and western representative of the late Dr. P. L. Pratley of Montreal, Quebec.

Special investigations and tests of materials were made by Professors Alexander Hrennikoff, M. ASCE, and W. M. Armstrong of the University of British Columbia, G. S. Eldridge and Company, materials testing firm of Vancouver, B. C., and Robert N. McLellan, also of Vancouver.

Eye witness testimony was taken in Vancouver from July 21 through July 23. Technical reports and evidence were heard during the period September 30 through October 16, the date on which summations were presented by Counsel. The Report of the Royal Commission was presented to His Honor, the Lieutenant Governor, by the 1st of December 1958.

The Second Narrows Bridge is being constructed by the British Columbia Toll Highways and Bridges Authority, acting through the Provincial Department of Highways, with Swan, Wooster and Partners, Vancouver, as the designing and supervising engineers.

The substructure was constructed by Peter Kiewit Sons Co., Ltd., and Raymond International Company, Ltd., as a joint venture, and the superstructure contract is held by the Dominion Bridge Company, Ltd., who are engaged in salvaging the wreckage and in refabricating and reerecting the structure.

At the time of the accident, erection of the north approach had been completed, consisting of four simple steel-deck-truss spans each 276 ft 4 in. long. Also nearly eight panels had been erected of the 10-panel north anchor span (a 465-ft steel deck truss) for the 1,100 ft channel span. See Fig. 1. A 465-ft South anchor arm connects with high bluffs overlooking Burrard Inlet.

The anchor span was supported by an anchor pier at its north end and by a falsework bent at the fourth panel point. Cantilever erection was to proceed to Panel Point 8, where the truss was to have landed on a similar falsework bent. From this point, the last two panels to complete the anchor arm at the north main pier were to have been erected.

At the time of the accident, the weight of the anchor arm and the erection equipment was concentrated on the falsework bent at the fourth panel. This bent consisted of two box-section columns seated on a double-tier, steel-beam grillage which in turn was supported by concrete-filled pipe piles driven firmly into the harbor bottom.

The report of the Commission's Engineering Advisers concluded that the collapse was due to the instability of the webs of the stringer beams serving as the upper tier of the falsework grillage supporting the anchor span at its fourth panel point, accentuated by plywood packings above and below these beams. The instability was due to the omission of stiffeners and effective diaphragming in the grillage, and this in turn was basically due to an error in the calculations. Such diaphragming as was provided was inadequate. The plywood used as "soft" packing above and below the upper tier of grillage beams of false bent N4 was a contributory cause of the failure of the grillage solely because of the absence of stiffeners and effective diaphragming in the upper tier of the grillage.

The error in the calculations consisted of using 1 in. instead of 0.653 in. as the web thickness and also using the entire area of the beams for the calculation of shear strength, whereas only the web area should have been considered as effective.

Investigations by the fabricating and erecting company led to similar conclusions. No evidence was presented from which it could be concluded that failure of any item other than the stringers comprising the upper tier of grillage in bent N4 initiated or contributed to the collapse of the bridge.

The buckling and collapse of the grillage beams induced a large eccentric moment in the columns, which in turn failed. Since this truss was firmly held at the anchor pier, the falling truss pulled the pier southward, rupturing it at the base of its shafts. The move-

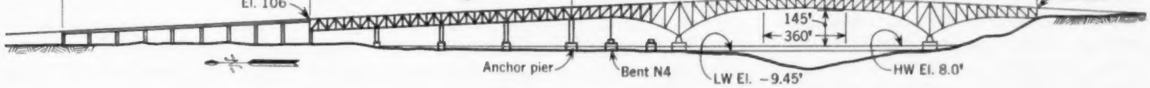


FIG. 1. Heavy lines show the portion of the structure in place at the time of the collapse, with the falsework bents at Panel Points 4 and 8.

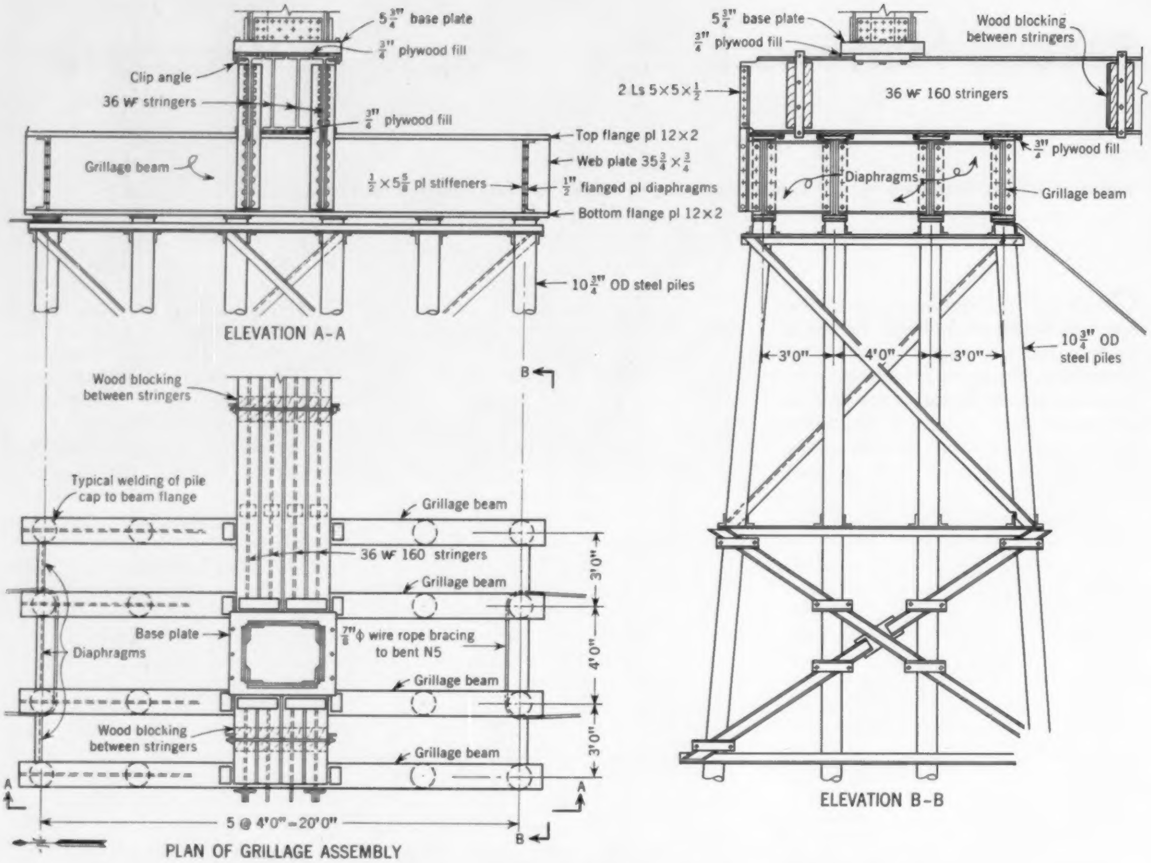


FIG. 2. Details of the grillage believed by the investigators to have been the cause of the failure. The upper grillage had only timber stiffeners, widely spaced.

ment was sufficient to pull the pier from beneath the bearings of the adjacent simple truss span, which in turn fell into the water and also was wrecked.

The findings of Chief Justice Lett, as set forth in the Report, with respect to the fabrication and erection contractor, Dominion Bridge Company Ltd., were as follows:

"The Bridge Company's contract specification included this clause:

'2-2-3. Falsework. The Contractor shall furnish, construct and subsequently remove all falsework required for the erection of the steelwork. Falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor shall submit to the Engineer, plans showing the falsework he proposes to use to enable the Engineer to satisfy himself that the falsework proposed to be used complies with the requirements of this Specification. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility. . . .'

"It will be noted that this clause contains two contractural obligations of the Bridge Company to the Authority, namely, to design properly and substantially construct the falsework, and to submit plans to the Engineers. . . .

"Accordingly, upon the evidence, my answer to this further question is that the collapse was caused by and was the result of negligence which consisted in:

"(a) failing properly to design and substantially to construct false bent N4 for the loads which would come upon it as requried by Clause 2-2-3 of the contract specification; and

"(b) failing to submit to the Engineers plans showing the falsework the Contractor proposed to use in the erection of span 5 as required by Clause 2-2-3; and

"(c) leaving the design of the upper grillage of false bent N4 to a comparatively inexperienced engineer, and failing to provide for adequate or effective checking of the design and the calculations made in connection with the design.

"For this negligence, I find the Dominion Bridge Company Limited responsible."

With respect to the Consulting Engineers, Swan, Wooster and Partners, the Report states:

"The specifications were drawn by the Engineers' firm and the Engineers accordingly must be presumed to have had full knowledge of Clause 2-2-3. . . .

"From the evidence, it is apparent that the Engineers [in not requesting the contractor to submit detailed plans of the falsework to them] were acting in accordance with a practice which existed in British Columbia, in so far as the Dominion Bridge Company was concerned, for a long period of years, and apparently down to 1954, when a clause similar to Clause 2-2-3 was for the first time included in the specifications of the Agassiz-Rosedale Bridge.

"It is clear from the evidence before me that had the Engineers called for plans showing the falsework which the Contractor proposed to use, in sufficient detail to enable the Engineers to satisfy themselves as to compliance

with the requirements of the specification the inadequacy of the upper grillage probably would have been discovered and the collapse avoided.

"The question is, was there in the circumstances here existing, an obligation on the Engineers to require the Contractor to submit plans of the falsework?

"There are three circumstances here which must be taken into consideration, the wording of the letter of May 17th, 1956 [the only written contract between the Bridge Authority and the Engineers], Clause 2-2-3 of the specification, and the ordinary professional relationship and duty of a consulting engineer to his client.

"In these circumstances, there was here, in my view, an obligation on the Engineers to satisfy themselves that the falsework proposed to be used complied with the requirements of the specifications, namely, that the falsework should be properly designed and substantially constructed for the loads which would come upon it. The Toll Authority's contract specifications had provided that the Contractor must submit plans of the falsework to the Engineers to enable them to satisfy themselves that the falsework complied with the requirements of the specification. The Engineers knew this. They must be taken to have known that the Toll Authority was relying on the Engineers to check the plans of the falsework. When the Contractor failed to submit these plans, it was the duty of the Engineers to their client, to require from the Contractor their production. This duty the Engineers failed to perform. In view of their long and successful association with the Contractor, this failure is understandable, but it cannot be overlooked. Accordingly, I must find there was a lack of care on the part of the Engineers in not requiring the Contractor to submit plans of the falsework.

"The evidence disclosed that it is the practice of those outstanding firms in the United Kingdom and the United States represented by the Commission's Advisers, Dr. Masters and Messrs. Giese, Otter and Freeman, to examine all falsework plans of any contractor, and to require submission of such plans, including the design, proposed method of erection, and in the case of some firms, to require calculation sheets or briefs used in the design. These witnesses made it clear that they were not testifying that this was the generally accepted practice of consulting engineers in their respective jurisdictions, but limited their evidence to the practice of their own particular firms. They indicated that by their practice they did not intend to relieve the contractor of his responsibility for the adequacy of the falsework."

Chief Justice Lett further recommended:

"Beyond saying that a Consulting Engineer must exercise all reasonable skill, care and diligence in the discharge of his duties, it is neither desirable nor practicable to lay down the precise boundaries within which such qualities should be exercised.

"However, evidence adduced in this Inquiry does seem to indicate that, in bridge construction work, and especially in the construction of long span or exceptionally large bridges, some Consulting Engineers recommend (either by reference to the appropriate national standard specification or in detail) the stresses to be used in the design of temporary works; and that the erection contractor shall submit to the engineer full particulars of the erection procedures and details of design of the temporary works which the contractor proposes to adopt, to enable the engineer to examine those procedures and details. The engineer performs that examination to the extent which he judges advisable in the circumstances. The contractor should not use the proposed temporary works in erection until the engineer has signified that he has completed his examination and that he has no objection to the contractor's proposals.

"Appropriate reservations could be made to ensure that the engineer does not in any sense assume or relieve the contractor of the contractual and financial responsibility for the adequacy of the contractor's proposed procedures and temporary works, whilst the contractor retains full freedom of choice of erection methods and procedure. The examination by the engineer nevertheless constitutes an additional means of discovering any latent engineering design or computation errors which may have escaped the notice of the contractor's own checking arrangements.

"In so far as the prevailing practice in British Columbia does not conform to the practice outlined above (and I make no finding upon the evidence adduced that it does not), it would seem to me that the adoption of such a practice in the contruction of large bridges in the Province would safeguard the interests of the public and of erection crews to the greatest practicable extent against the inherent and ever-present dangers of human error, and I recommend that if Your Honor sees fit, this matter might be brought to the attention of the Professional Engineers in the Province for consideration.

"I further recommend that this practice be adopted in relation to the remaining construction of the Second Narrows Bridge. The examination by the Advisers to the Commission of the detailed plans of the Contractor and Consulting Engineers, of necessity, was confined to the construction up to the point of collapse. They were not asked, and had no opportunity to check into erection methods to be used for completing the central span. There is then no evidence before me as to what checks have been or are being made in respect to the remaining construction.

"In the light of what has happened, I recommend to the Authority that it require the Consulting Engineers to demand of the Contractors all their proposed plans . . . for the erection of the remainder of the work to enable the Engineers to examine those procedures and details. . . . The Contractor should not use any temporary works in erection until the Engineers have signified that they have completed their examination and have no objection to the Contractor's proposals."

Erection continues by planned method

OFFICIALS of Dominion Bridge Co., Ltd., have told the editors of CIVIL ENGINEERING that erection of the Second Narrows Bridge at Vancouver will be completed following substantially the planned method of erection. The fallen spans have been disassembled and reusable members salvaged. Replacement parts are in process of fabrication. The damaged anchor-pier columns are being replaced.

Erection has shifted to the other end of the cantilever span. The south anchor arm is being erected over falsework bents. Derricks operating on the structure will handle the complete erection of the cantilever span, working from each end to meet at the center.

The pile bent at N4, where failure of the grillage is believed to have initiated the collapse, suffered only very minor local damage and will be reused with little repair. The pile bent under Panel Point 8, not then in use, was damaged by falling steel; it will be rebuilt and used as planned. No falsework is contemplated for the 1,100-ft channel span.

The collapse was due to an error in a routine design calculation for a grillage. The computations were made by one engineer and checked, as is standard practice, by another engineer, the latter with 21 years' experience with the erection contractor. This illustrates the ever present risks that are inherent in construction, due to human error. The failure emphasizes the need for utilization of all possible checks on construction procedures. EDITOR.

ENGINEERS' NOTEBOOK

Hydrographic surveying from a helicopter

JAMES W. POIROT, J.M. ASCE, Civil Engineer, Cornell, Howland, Hayes and Merryfield, Corvallis, Oreg.

The waste disposal system for the Georgia-Pacific kraft paper mill at Toledo, Oreg., includes an 8½-mile pipeline which carries the strong waste from the mill to the ocean at Newport, Oreg. The pipeline was designed by Cornell, Howland, Hayes & Merryfield, consulting engineers, of Corvallis, Oreg. Its discharge extends into the ocean approximately 1,000 ft at high tide; at extreme low tide the end of the pipeline is exposed. The discharge point was originally chosen at the location the farthest from shore that could be reached by the use of dry-land construction methods at low tide. The method used was to cut a trench through the rock reefs and backfill the pipeline with concrete to anchor it in position.

To help reduce odors and foam, extension of the pipeline into deeper water was recently investigated, and to properly analyze the economics involved, topographic information on the reefs was considered essential. As can be seen from the photographs, the beaches are lined with rock reefs which make travel in boats extremely dangerous. The employment of skin divers wearing protective clothing was considered but later abandoned because of the heavy surfs that continually pound against the barnacle-covered rocks. The use of a helicopter was finally decided on.

On the morning of May 6, 1958, at 8:25 a.m., a − 1.4-ft tide (M.L.L.W.) occurred. On the preceding day arrangements were made with the Livingston Air Service of Corvallis, Oreg., to utilize their three-place helicopter in conjunction with a ground survey crew to establish elevations of reefs and holes beyond the end of the pipeline. The ground survey crew consisted of two transitmen and one levelman to establish the locations of the soundings and the elevation of the helicopter during the operation.

A level placed on a high rock was used to locate the helicopter on a level plane during each sounding. As the helicopter approached the location of the sounding point, a yellow flag was waved from the helicopter to inform the levelman that a sounding was about to be made. The levelman then signaled back to the helicopter that it should either rise or drop lower to get on the level plane. When the helicopter was on the level plane, the sounding was taken with a metallic-cloth tape carrying a 5-lb lead weight, and a signal was given to the transitmen to record the angle and time of the sounding.

All soundings and transit shots were coordinated by recording the time of the sounding and the time the angles were read. The two transits on the beach were set on a base line 767 ft long. By triangulation of the two transit shots, the position of each sounding was found.

To simplify the plotting of the sounding locations, each group of soundings was made along a straight line established by flags on the beach. This provided a check in locating the sounding points.

About 50 soundings were taken in a two-hour period in the area of the proposed pipeline extension. Of these, about 60 percent were considered accurate and were used to plot the topography of the reefs. The levelman indicated that the helicopter was on the correct elevation when it varied within a foot of the level plane. The majority of the soundings were considered accurate within 2 ft, which was satisfactory for the type of information desired.

After the elevations were plotted, they were transferred to a vertical aerial photo taken during a low tide. By observing the reefs and noting the elevations of their tops and the adjacent holes, it was evident that there was only one practical location for the pipeline extension. Study of additional aerial photos taken during the soundings helped to verify this location.

In view below, helicopter moves out to sounding area while transitman at left center and levelman on rock at right wait to take shots. Levelman will signal helicopter to rise or drop lower to get on level plane. In view at right, helicopter drops metallic-cloth tape carrying 5-lb lead weight. At the same time it signals transitmen to record time and angle.

Finding bearing of a 24-in pile by a load on a 16-in pile

DOUGLAS BROWN, J.M. ASCE, Senior Engineering Geologist, Bridge Department, California Division of Highways, Los Angeles, Calif.

A load-testing problem for piles of 24-in. diameter cast in drilled holes arose when the use of such piles for a viaduct was considered by the California Division of Highways. The desired ultimate load of 200 tons was greater than could be applied by the load-test trusses possessed by the state at the time. A method was devised to determine the bearing by extrapolation from tests on a smaller model pile of 16-in. diameter to a maximum load of 150 tons by the reaction method. The method, described below, is a special application but a similar approach could be used for other pile sizes and loads.

Both the 16-in. and the 24-in. piles are cast in drilled holes and are of constant diameter, but they are not geometrically similar since the ratio of the end areas is different from the ratio of the perimeter areas. The 16-in. test pile and two adjacent anchor piles must extend to the same depth as the 24-in. pile so that the unit end bearing and the average unit perimeter shear will be the same. The load is applied to the center or test pile by a load-test beam or truss utilizing the two anchor piles for reaction. The notation is as follows:

B = ultimate or total bearing as determined by load test

E = end bearing

P = perimeter shear or skin friction (determined by load test if one of the anchor piles fails)

PERIMETER AREA

16-in. pile = 4.2 ft² per ft
24-in. pile = 6.29 ft² per ft

END AREA

16-in. pile = 1.4 ft²
24-in. pile = 3.14 ft²

$$B_{16} = E_{16} + P_{16}$$

$$B_{24} = \frac{3.14}{1.4} E_{16} + \frac{6.29}{4.2} P_{16}$$

$$B_{24} = 2.24\ E_{16} + 1.5\ P_{16}$$

Assume $B_{24} = 200$ tons, since this is the desired load, and reduce to

$$133 = 1.5\ E_{16} + P_{16}$$

A graph of this equation is shown in Fig. 1. All points above the line indicate an ultimate bearing strength in excess of 200 tons. The problem is to determine the coordinates of the test.

Suppose the test pile supports 150 tons (the assumed maximum capacity of the test equipment) without pulling an anchor, then $B_{24} = 1.5 \times 150 = 225$, even assuming all bearing to be skin friction, and a higher bearing if a portion of it is end bearing (since the ratio of E_{24} to E_{16} is 2.24, which is higher than 1.5).

For the worst case, that of perimeter shear bearing only, the 24-in. pile will definitely be good for 200 tons only if the 16-in. pile is good for at least 133 tons (see Fig. 1). However, if a pile fails at less than 133 tons without pulling an anchor, the problem will be indeterminate. For example, if failure occurs at 130 tons, without pulling an anchor pile, we know that P_{16} may vary from 65 to 130, while correspondingly, E_{16} may vary from 65 to zero. Other cases will describe parallel lines in the indeterminate range, the upper limit of which is 133 tons as described above.

The best case at the lower limit is where the bearing is all end bearing and a load of approximately 90 tons (upper intercept of the line equation) might result in a load capacity of 200 tons on a 24-in. pile. This load could not be applied by the reaction method because the anchor piles would not hold. However, piles cast in drilled holes are seldom end bearing and rarely pull out when used as anchor piles. Assuming that the anchor does not pull out, the best case possible is where $E_{16} = P_{16}$ (or approaches it). The intersection of the line representing $P_{16} = E_{16}$ intersects the line representing $133 = 1.5\ E_{16} + P_{16}$ at $E_{16} = 53.2$, and $P_{16} = 53.2$. This is a total load bearing of 106.4 tons, which is the lower limit of the indeterminate range, below which failure is positive.

For cases in the indeterminate range, an estimate of P_{16} or E_{16} must be made. For the example plotted in Fig. 1, where the total capacity is 130 tons, it is obvious that only 5 tons of end bearing is required to make the pile good. Failure at lower test loads may be more doubtful and may require:

1. Reduction of the anchor-pile diameter so that P_{16} can be determined. P_{16} can be extrapolated from the pulling deflection curve without actual failure, so that a high load can still be applied to the test pile.
2. A separate pulling test by pulling on the center pile and jacking at the ends of the load-test beam or truss.
3. Estimation of E_{16} by $E_{16} = 0.6\ N$, where N is the number of blows required to drive a standard penetration sampler one foot in the material under the pile tip.

If there is a tendency to drill the holes oversize, a correction based on the actual diameter should be used, since the bearing of the larger pile would not be increased at the same rate.

This general method of model analysis can be applied to consant-diameter piles of other sizes.

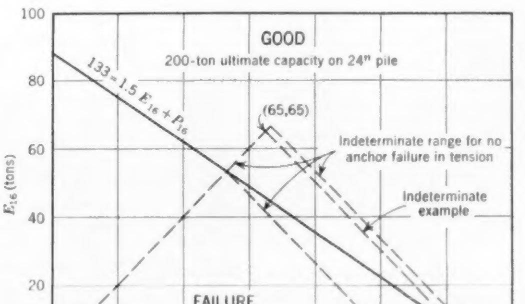


Fig. 1. For worst case, that of perimeter shear bearing only, the 24-in. pile will be good for 200 tons only if the 16-in. pile is good for at least 133 tons.

Proportioning a mix of three soils by graph

GERT ARON, *Graduate Student, State University of Iowa, Iowa City*

MIXING two or more types of soil of known grain-size characteristics to meet certain specifications is a problem that many a builder or contractor often faces. If two available soils will satisfy the specifications, several methods, analytical and graphical, are known for solving the problem of proportioning.

If, however, three soils have to be mixed, the problem becomes more complex. The usual method in such a case is to choose first a blend of two of the soils by trial and error, and then to compute the necessary proportions of this blend with the third soil. This method, while useful in arriving at a satisfactory mix, will often allow the builder only a small range of possible proportions.

Frequently, however, it may be very convenient and economical to find the full range of all possible mixes that will comply with the specifications, especially where the several soils are available at different costs or in different quantities. A direct solution for such proportioning of three soils is here presented.

For the example demonstrated by the graph, Fig. 1, the sieve analyses of three soils (A, B and C) and the specifications are given in Table I. To trace the range lines limiting the soil proportions, the following procedure is used. The lines are plotted from the computed proportions shown in Table II. For the specified limit of 70 percent passing the ⅜-in. sieve, for example, just two mixes of the soils, resulting in 70 percent passing that sieve, are needed. Since soil A has 12 percent, soil B, 90 percent, and soil C, 100 percent passing the sieve, the two simplest possible mixes are, by straight interpolation:

(1) Zero % of B; $\dfrac{100-70}{100-12}$

$= 31.4\%$ of A; and 65.9% of C.

(2) Zero % of C; $\dfrac{90-70}{90-12}$

$= 25.7\%$ of A; and 74.3% of B.

These two sets of points for soils A, B, and C can now be plotted on the triaxial graph and connected by a straight line. Every point on this line will represent a mix with 70 percent passing the ⅜-in. sieve, which will be proved at the end of this article.

By the same procedure two lines, which incidentally are parallel, can be plotted for each sieve, representing the specification limits. The area falling inside all these limiting pairs of lines will represent the full range of mixes meeting the specifications.

Suppose that the cost per unit volume is different for soils A, B and C so that, for example, A costs \$10; B, \$12; and C, \$20. It is now necessary to find the most economical mix. This will be found in one of the corners of the range area, representing in this case as low a percentage as possible of the expensive soil C and as high a percentage as possible of the cheap soil A.

Computing the cost per unit volume of the mixes shown in the three corners representing the lowest percentage of soil C, it will be found that the mix made up of 26 percent of A, 41.8 per-

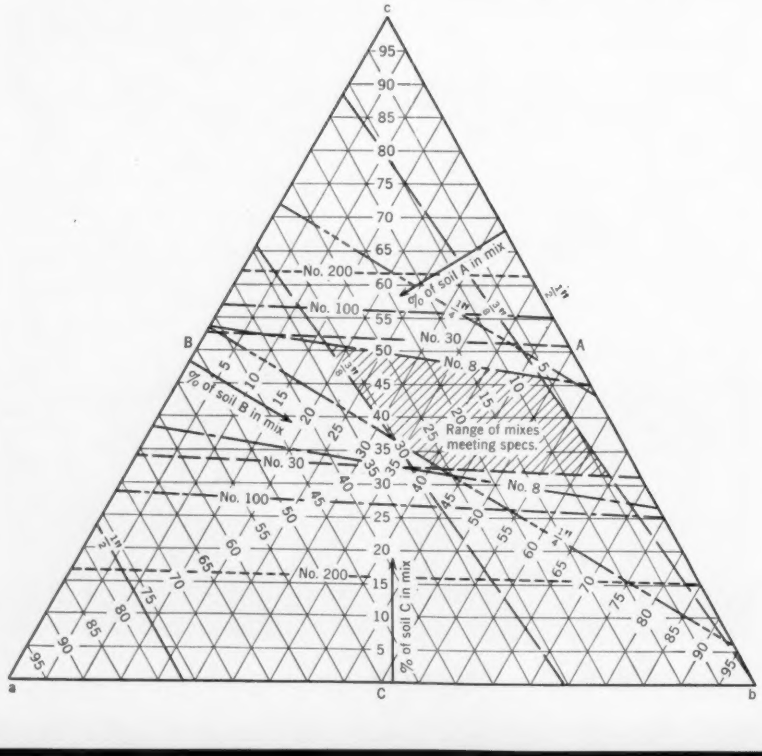
TABLE I. Grain-size analysis

Sieve Size	Percentage Passing			
	Specs.	Soil A	Soil B	Soil C
½ in.	80-100	74	100	100
⅜ in.	70-90	12	90	100
¼ in.	55-73	3	52	100
No. 8	40-55	2.5	18	100
No. 30	20-30	2	4	55
No. 100	10-18	2	3.2	30
No. 200	4-10	1.8	2	15

TABLE II. Proportions

Sieve Size	Spec. Limits, % Passing	% of Soils		
		Soil A	Soil B	Soil C
½ in.		76.9	0	23.1
	80	76.9	23.1	0
	100	0	any	%
⅜ in		25.7	74.3	0
	70	34.1	0	65.9
	90	0	100	0
		11.4	0	88.6
¼ in.		46.5	0	53.5
	55	0	94.4	6.0
	73	27.8	0	72.2
		0	56.3	43.7
No. 8		61.6	0	38.4
	40	0	73.1	26.9
	55	46.1	0	53.9
		0	55.0	45.0
No. 30		66.0	0	34.0
	20	0	68.8	31.2
	30	47.2	0	52.8
		0	49.0	51.0
No. 100		71.5	0	28.5
	10	0	74.8	25.2
	18	43.0	0	57.0
		0	44.8	55.2
No. 200		83.3	0	16.7
	4	0	84.8	15.2
	10	37.8	0	62.2
		0	38.5	61.5

FIG. 1. Graph determines full range of possible proportions of three soils of known grain sizes, to meet specifications as given in Table I. Lines are plotted from the computed proportions shown in Table II.



cent of B, and 32.2 percent of C, at a cost of \$14.05, is the cheapest obtainable that will still meet the specifications.

Graphically, an "iso-cost" line could be drawn between the two sets of points, as for example, A = 0 %, B = 100 %, C = 0 %, and A = 80 %, B = 0 %, C = 20 %—an easily established line of constant cost at \$12 per unit volume. Since all "iso-cost" lines are parallel to each other, the cheapest mix can be found by sliding a straight-edge up parallel to this \$12 line until we find the first and "cheapest" corner.

The proof that all mixes resulting in a certain percentage passing a certain sieve are represented by points in a straight line is as follows.

Suppose that x % of a soil A (with a % passing sieve S), plus y % of a soil B (with b % passing sieve S), plus z % of a soil C (with c % passing sieve S), as well as x' percent of soil A plus y' percent of soil B plus z' percent of soil C, will make mixes with the desired d percent passing sieve S. These two sets of proportions would be plotted as two points and connected by a straight line as explained previously. Then $xa + yb + zc = x'a + y'b + z'c = 100$ percent of d.

For any point on this line,
$[x + n(x' - x)]\ a + [y + n(y' - y)]\ b + [z + n(z' - z)]\ c = xa + yb + zc + n(x'a + y'b + z'c) - n(xa + yb + zc) = (100\%\text{ of }d) + n(100\%\text{ of }d) - n(100\%\text{ of }d) = 100\%\text{ of }d$.

THE READERS WRITE

Trusses designed to save material are not new

To THE EDITOR: The presentation by Mr. P. H. Cheng in your November issue, vol. p. 838, is helpful in encouraging a general discussion of truss analysis. However, neither the idea nor the use of such structures is at all new. It is simply a restatement of the basic principle that every chord member of a truss has both direct and bending stresses, and that the bending stresses are of greatest importance in those chord members which also act as roof or floor beams or trusses.

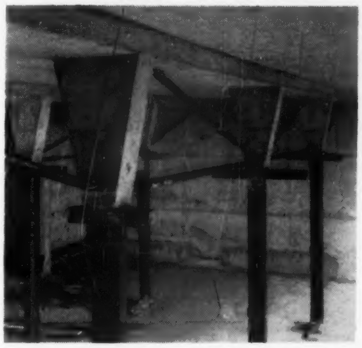
On October 3, 1882, a patent was granted to P. H. Jackson for calling attention to the use of joint eccentricities in order to reduce the stress in the individual segments. Mr. Cheng's Figs. 4 and 5 are quite similar to some of the drawings used to illustrate the patent.

Many patents have been issued for various specific applications of this principle since Mr. Jackson's 1882 patent. The undersigned hold patents which successfully apply this principle to the timber "Mack" trusses manufactured by Vo-Vec Roof Structures and widely used in Southern California. Cost savings of 5 to 15 percent are achieved. Fewer panels and web members are required, and moments can be carried across the joints in a segmented truss to give it some of the economical properties of a truss with continuous chords.

We have other patents that apply similar principles to the design and construction of steel trusses of various sizes. These have proved very economical. Because the joints are designed in a balanced fashion to be free from rotation, the trusses are almost without secondary stresses and the distortion they produce.

The accompanying photo shows these principles applied to a reinforced concrete structure which we designed in 1957. Both three- and four-bay trusses were used. (Mr. Cheng's Figs. 1 and 2 are quite similar.) The upper chords of these trusses, formed by dropped panels in the floor, resist a large compressive force since the trusses are shallow.

For bending and compression in the concrete beam, the principles of design are not at all new, but because compressive stresses were high it was helpful to use the methods of analysis now commonly used in prestressed concrete. It was of interest to note that by the use of the truss structure shown in the photos, clear spans of 45 ft were obtained in a five-story office building and the center row of columns thus eliminated. The cost for the clear-span structure was estimated to be the same as that for conventional construction with columns 22½ ft on centers.



Three-bay truss (top) and four-bay truss (bottom) were used in office building in Beverly Hills, Calif. Engineers were Mackintosh & Mackintosh; architect, Sidney Eisenshtat; and contractor, S. Jon Kreedman & Co.

CHARLES MACKINTOSH
Mackintosh & Mackintosh, Consulting Engineers
Los Angeles, Calif.

Economy of aluminum for long-span roofs

To THE EDITOR: A careful examination of my article, "Aluminum Roof Proves Economical—for Transportation Pavilion at Brussels World Fair," in the Oct. 1958 issue, vol. p. 729, reveals two errors, no doubt typographical, that did not occur in the French text.

On vol. p. 732, first column, the 24th line should read:

"W' must equal αW, instead of "W' must equal W."

Equation 2 that follows is correct.

The second error occurs on the same page, second column, in Eq. 4, which should read:

$$k \leq \frac{\beta\gamma - \rho}{\rho - \beta} \text{ instead of } k \leq \frac{\beta\gamma - \rho}{\rho + \beta}$$

These corrections answer the first point raised by Mr. Preece in his discussion, in the December issue (vol. p. 936), of my article.

Mr. Preece is astonished by the simplicity of my theory and especially by the fact that my formula contains no terms for such properties as modulus of elasticity, depth to span ratio, etc. My

theory assumes, of course, that in the two cases each of the materials compared can work at its own safe tension. Obviously the deformations will not be the same in both cases and the theory is applicable only if the maximum deformation of the aluminum member is acceptable. I refer to this subject in my article, vol. p. 733, col. 1, paragraphs 2 and 3. Moreover, the comparison is between two structures of the same shape, type, and dimensions; the height and the span are thus also the same.

I am aware that Eq. 4 and the graphs based on it do not solve all the problems of the design. They are intended only to aid the designer when he wants to find out, at the beginning of his work, in a minimum of time and merely as a first approximation, whether a solution in aluminum will be economically feasible. From this point of view I believe that the simplicity of Eq. 4 is not a fault and that it can be of service to the engineer who is thinking of making a study of an aluminum frame.

I cannot agree with the statement of Mr. Preece that, "Furthermore, aluminum and steel tension members will probably be of equal weight if the capacity is limited by allowable strain."

Actually the safe tension of aluminum is around 0.83 times that of steel, while the specific weight of aluminum is only 0.344 times that of steel. Thus the aluminum member will certainly be lighter than the steel member.

I sincerely appreciate Mr. Preece's careful study of my article and also his words of praise for the Transportation Pavilion.

A. Lipski
Consulting Engineer
Brussels, Belgium

Plug-in formulas not generally desirable

To the Editor: With reference to the article in the November issue, vol. p. 856, by John F. Tanner, "Traverse Closure as a Mathematical Method," I would like to make the following points:

1. The problem as presented by Mr. Tanner is neither difficult nor unusual and can be solved in about five steps. The information needed for closure can be easily obtained by first solving the right triangle AC'C for the distance and bearing of a line drawn from point A to point C and then solving triangle ABC for the bearing of side BC and the distance of side AB by the law of sines.

2. It is admitted that the two equations developed by Mr. Tanner could be used for direct solution of any closure of this nature, but it should be pointed out that traverses can take many shapes and the use of plug-in formulas is not generally a desirable practice, except in special cases.

Plato Collins, A.M. ASCE
J. E. Greiner Co. & Associates, Inc.
Engineers-Architects
Albany, Ga.

Objection raised to new definition of engineering

To the Editor: I disagree with the new definition of engineering proposed by the Engineers Council for Professional Development and endorsed by the ASCE Board of Direction at its meeting in Chicago, February 24-25, 1958. This definition appears in ASCE's Annual Report for 1958, on p. 11. It reads:

"Engineering is a profession in which a knowledge of the mathematical and physical sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of Nature for the progressive well-being of mankind."

My objection centers around the error in identity that occurs when engineering is equated with profession, as defined above. Engineering is a universal art; a profession is a matter of personal conduct.

The facts show that engineering is a difficult art, similar in some respects to the arts of religion, politics, medicine, and law.

Some men dedicate themselves to the study and practice of engineering as a profession. Others use engineering merely as a tool in trade. The conduct of the practitioner in engineering, religion, and medicine is not controlled by the art. Each is free to use his art according to his lights. The practice of engineering is not monopolized by engineers. In this respect it differs from the practice of law. However, who shall presume to say what is right conduct? God bless the freedom of the U.S.A.

R. B. Macfarlane, M. ASCE
Macfarlane & Sadler
Consulting Engineers
Richmond, Va.

Simplified deflection calculations presented

To the Editor: Mr. Heinz is to be commended for having emphasized the usefulness of the virtual work method for the computation of deflections, in his article, "Simplified Deflection Calculations by Virtual Work," in the November 1958 issue, vol. p. 853.

However, the algebraic work can be shortened substantially. The force "1" in his Fig. 3 can be applied to a statically determinate system of that frame. Then the moments caused by this force and the indeterminate forces would furnish, by superposition, the stresses shown as "*m* moments" in Fig. 3. But since by definition the points of application of these indeterminate forces do not deflect or rotate, they do not contribute to the work, $\int M\, m\, ds$.

In the illustrative problem, it is sufficient to apply the force "1" to a statically determinate system as shown in the accompanying Fig. 1. The algebraic computation, using Mr. Heinz's Eq. 4, consists of $EI\delta = \frac{20.0}{3}\left[75.2 + \frac{1}{2}(9.2)\right]20.0 = 10{,}640 \approx 10{,}720$ as computed in the article.

Any statically determinate, stable system of an investigated structure will yield the required result. The one selected should be that which reduces the algebraic work to a minimum. Also, the *M* and *m* moments can be exchanged to simplify the computation if the moments due to the actual loads are not known and/or not required.

Deflection due to other than direct loads can also be easily computed. Results for various $\int M\, m\, ds$ will be found in textbooks dealing with the analysis of statically indeterminate structures. For example, in Fig. 2 the frame investigated in Mr. Heinz's article is acted upon by a uniform horizontal loading. The deflection is

$$\delta_2 = \frac{1}{EI}\frac{20.0}{3}\big(\underbrace{180.0 + \tfrac{1}{2}\,67.6}_{\substack{\text{trapezoid}\\ abcd}} \underbrace{- \tfrac{1}{2}\,100.0}_{\substack{\text{triangle}\\ ace}} \underbrace{- 25.0}_{\substack{\text{parabola}\\ aef}}\big)\,20.0 = \frac{1}{EI}\,18{,}540.$$

Hermann Zutraun, M. ASCE
Project Engr., Moran,
Proctor, Mueser & Rutledge
Forest Hills, N. Y.

FIG. 1

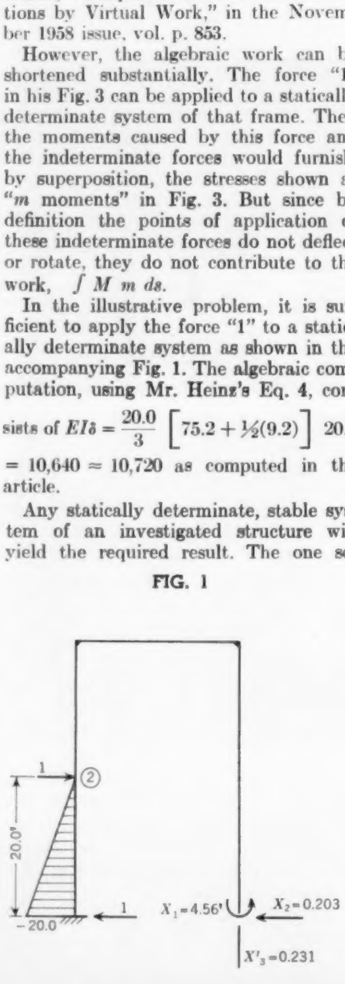
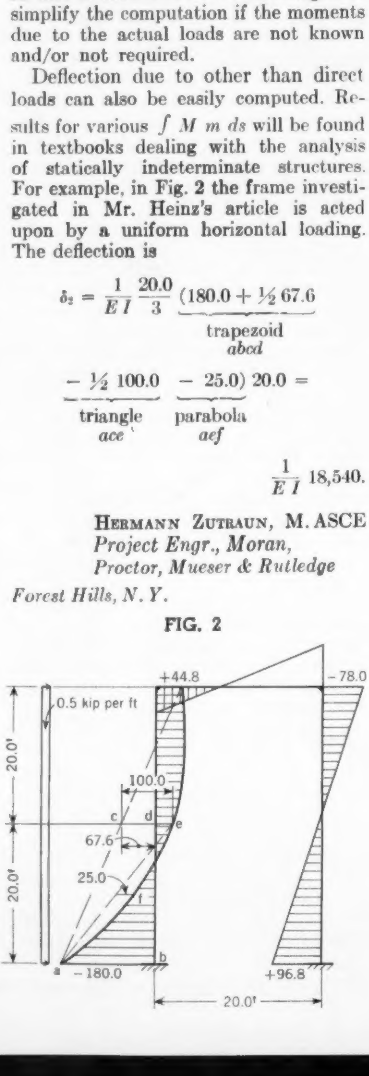


FIG. 2



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SOCIETY NEWS

Progress Toward A United Engineering Center

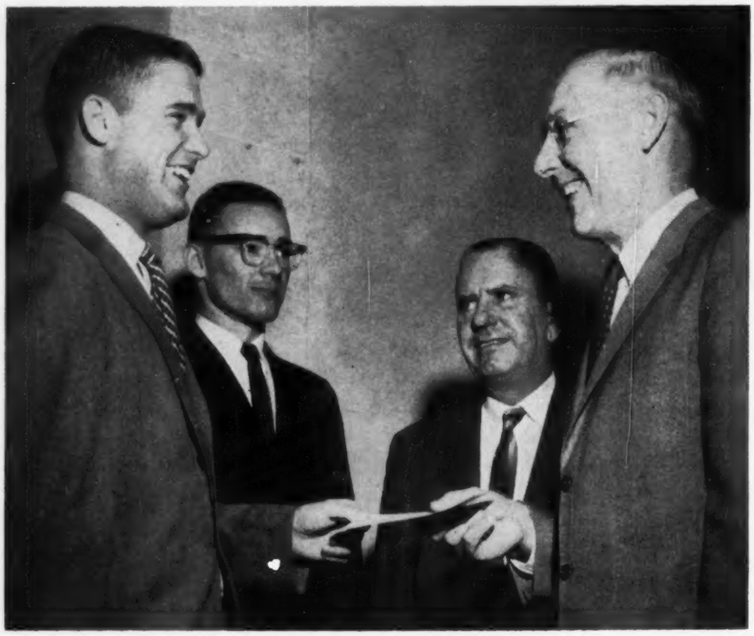
A year-end report of problems encountered and progress made in the campaign for funds for the new United Engineering Center has been released by C. E. Davies, director of the project. By the time this reaches members in February, says Mr. Davies, "there will doubtless be more progress and new, if not fewer, problems. Right now, at the close of 1958, there is a healthy balance of progress and problems—the kind of balance that always stimulates and challenges engineers."

Under the head of "progress," he points out that "In a little over a year, the United Engineering Trustees and their Real Estate Committee have secured what the experts call the best site in New York, on the west side of United Nations Plaza between East 47th and East 48th Streets. This site was assembled after negotiating purchases of a variety of small properties from six different, and some difficult, owners. The last of the tenants have moved, demolition of the buildings is complete, and the site was cleared early in January. The general contractor should be selected in February. Shortly after the funds are in hand, ground breaking could take place, and if all goes well, the building can be completed by early 1961. The "if-all-goes-well" is a part of the problem to be discussed shortly.

"The architects, Shreve, Lamb, and Harmon Associates, have completed preliminary plans and called for bids on the general contract. Only a courageous architect would undertake a building for a group of engineers. In this case, courage is reinforced by experience. This firm has for many years been consulting architects to United Engineering Trustees on alterations and plans for renovation and replacement of the present building on 39th Street. Many details are yet to be settled, but the basic plan is agreed upon. There will be a 20-story tower with penthouses rising from a two-story basic structure over a basement. The gross floor area will be 280,000 sq ft. The tower will be approximately 65 by 140 ft. The basement and two large floors housing the library, cafeteria, and central services will occupy the United Nations Plaza block front to a depth of 225 ft on 48th Street and 150 ft on 47th Street. Present plans call for a 13-story wing to provide for expansion when needed about fifteen years from now.

About "problems," Mr. Davies has this to say in part: "It isn't right to put the matter of finances entirely under the head of 'problems.' More than half of this story belongs under 'progress.' Of the $8 million needed, $5.5 million have been given in cash or pledged by the end of December 1958. Two hundred eighty-four industry gifts totaling $3.85 million have been received. Thirty-two thousand members have given $1.65 million. Seventeen and seven tenths percent of the Founder Society members have given 55 percent of the member-gifts quota. More than 40 local sections of the Founder Societies have met and exceeded their quotas. That's progress.

"The only real problem is how to put clearly before every member of the Founder Societies the importance and urgency of this project. Every local section that has made a personal appeal to every member has exceeded its quota. There is every reason to be sure that the job can be done as it should be—on a



One heartening phase of the campaign for funds is the interest shown by the Society's Student Chapters—symbolic of the close bonds linking engineering students and practicing engineers. In this view John R. Olds (left), president of ASCE Student Chapter at the University of Illinois, presents $50 check to Paul L. Zumwalt (right), president of the Central Illinois Section. Others in the group are Byron E. Marks (second from left), Chapter vice president, and H. O. Sheer, vice president of the Section.

man-to-man basis where the member lives and works.

"The consequences of failure are unthinkable. Over fifty years ago, the original three "Founder Societies," numbering 16,000, less than a tenth of the total membership of the present five, 180,000, raised by member subscriptions over half a million dollars (1907 dollars, that is) to buy the ground and help build the present headquarters on 39th Street. The gift of Andrew Carnegie, $1,050,000, then was of a relative size comparable with what industry is undertaking to do now considering inflation, increased building costs, and wealth of the industry today. It is hard to believe that these fifty years have brought a regression in professional consciousness and pride that would permit a failure in this campaign. We can't settle for less of a building; we can't afford a mortgage; we can't continue to serve our growing membership in our present location.

"Engineering, as an organized profession is facing a test. There is much talk of 'unity;' there is said to be need for a 'survey;' there is talk of 'testing the grass roots.' This campaign for a very modest sum of money will serve very well for all of these purposes. If we can't successfully take this small step toward a simple, tangible goal in unison, we have our answer. That's all the survey we need. Truly, the consequences of failure are unthinkable. So, let's not think any more about them, and get on with the job. We are a little behind schedule, that's all. . . ."

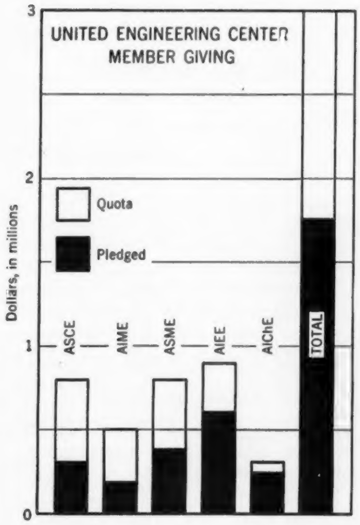


FIG. 1. Member Giving for UEC as of January 9.

UEC HONOR ROLL

Kentucky
Lehigh Valley
Nashville
Cincinnati
Columbia
Philadelphia
Hawaii

Several ASCE Sections have met their full quota of contribution to the United Engineering Center. Due to a change in the method of recording, all contributions have not been tabulated by Sections to verify and make this complete. In order of reporting to Society headquarters, the Sections listed here are on the UEC HONOR ROLL.

Table I. Quotas and Pledges to UEC as of January 16

Society	Goals in Dollars	No. of Subscribers	Amount Pledged	% of Goal	$ per Subscriber
ASCE	800,000	4,624	333,540	42	73
AIME	500,000	2,012	194,287	30	96
ASME	800,000	7,467	395,886	49	53
AIEE	900,000	16,176	629,932	70	39
AIChE	300,000	5,724	252,751	84	44
Others	......	244	28,784	..	118
Total	*3,000,000	36,247	1,835,144	61	53
Industry	5,000,000	317	3,927,218	78	12,400
Grand Total	8,000,000	36,664	5,762,362	71	

* While the overall goal of member giving is shown as $3,000,000, the quotas accepted by the Societies total $3,300,000.

Fifth Nuclear Congress To Be Held in Cleveland

Details of the 1959 Nuclear Congress, the nation's largest gathering of specialists in the atomic field, have been announced by Engineers Joint Council, the coordinating agency. The five-day program, which will begin at the Public Auditorium in Cleveland on April 5, will include the Fifth Nuclear Engineering and Science Conference, the Seventh Hot Laboratories and Equipment Conference, the Seventh Atomic Energy Management Conference, and an "Atomfair."

The forty technical sessions will be devoted to papers covering advances in reactor technology and the use of radioactive materials, problems of industrial management in the nuclear field, and laboratory problems in radioactive materials. Guest speakers will include specialists from England, France, Italy, and Russia. Russian engineers will describe their power reactor program, including details of a 600,000-kw power plant reported to be under construction in Siberia. Of much interest, also, will be a luncheon meeting address by Sir Claude Gibb, managing director of C. A. Parsons, Ltd., one of England's leading nuclear development firms.

The theme of the congress, which is being sponsored by more than thirty leading engineering, scientific, and management groups is "For Mankind's Progress."

Inquiries about the congress should be addressed to Congress Director T. A. Marshall, Jr., c/o Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

EJC Citations for Promoting Careers in Engineering

Engineers Joint Council has cited the Westinghouse Educational Foundation and the Carnegie Institute of Technology for their pioneer work in encouraging young men and women to seek careers in engineering and science. The citation was presented by President Enoch R. Needles to John A. Hutcheson, president of the Westinghouse Educational Foundation, at a recent meeting of the EJC Board of Directors. In accepting on behalf of the Foundation, which is supported solely by the Westinghouse Electric Corporation, Dr. Hutcheson outlined a new program in which laboratory equipment is being offered free to all of the nearly 150 accredited electrical engineering departments in colleges and universities.

This year marks the completion of twenty years of George Westinghouse Scholarships at Carnegie Tech. Each year, since 1938, ten four-year scholarships have been awarded to secondary school seniors selected annually from over 1,000 applicants, in nationwide competition.

The citation hails the two groups "for helping to enable brilliant minds to pursue higher education in engineering and science, which otherwise would have been lost to the nation."

Donald D. King Succeeds R. K. Lockwood as Assistant to Secretary of ASCE

Donald D. King, M.ASCE, has been named Assistant to the Secretary of ASCE, in the New York headquarters office. He succeeds **Robert K. Lockwood**, A.M.ASCE, who has resigned to take the position of advertising manager and director of public relations for the Sika Chemical Corporation, Passaic, N. J.

Donald D. King

A civil engineering graduate of Iowa State College, Mr. King was a member of the original CIVIL ENGINEERING staff when the publication was initiated in 1930. For the next thirteen years he was assistant editor in charge of art and production for CIVIL ENGINEERING and other ASCE publications. Later he was with the Office of the Air Engineer, AAF, as editor of the Army publication, *Aviation Engineer Notes*, and assistant editor of *Construction Methods*. In 1946 he returned to the Society as editor of CIVIL ENGINEERING, a position he held through 1948. In 1949 Mr. King helped launch the magazine, *Construction Equipment*, and served as editor in chief until 1957. In 1958 he was feature editor for *Contractors and Engineers*. He has served as a member of the executive committee of the National Safety Council's Construction Division.

Long active in the Society, Mr. King has been on the Metropolitan Section's Annual Convention committee for several years. He has also been secretary of the Construction Division's Committee on Adverse Weather Conditions since its formation. In his new capacity at headquarters, he will be responsible for coordinating the Society's activities in the Department of Conditions of Practice, including education, registration, salaries, and employment conditions.

R. K. Lockwood

Mr. Lockwood, a 1948 civil engineering graduate of the College of the City of New York, was on the ASCE headquarters staff for ten years. He was associate editor of CIVIL ENGINEERING from 1948 to 1954 and executive editor from 1954 to 1957. In the latter year he was transferred to a position as Assistant to the Executive Secretary. In World War II Mr. Lockwood served in the Infantry, commanding a platoon in the Philippines, and later was in charge of the industrial demobilization of Japan in a three-prefect zone. Since the war he has been in the Corps of Engineers Reserve, and now has the rank of Major. Active in the Metropolitan Section, he was a prime mover in starting its newsletter a few years ago. He has also been president of the Section's Junior Forum.

ASCE Manual on Sewage Treatment Plant Design

Several years of work by a joint committee of the Sanitary Engineering Division of ASCE and the Federation of Sewage and Industrial Wastes Associations are now culminated with the issuance of a manual on "Sewage Treatment Plant Design." In this manual the joint committee has summarized and interpreted current practice in the design of sewage treatment plants. The committee does not attempt to approve or disapprove the practice, but merely reports what is being done.

Copies of the new ASCE Manual (No. 36) can be obtained from ASCE by use of the coupon on page 145 of this issue. Engineers who are members of FSIWA but not of ASCE are urged to order their copies through the Federation so that the member discount of 50 percent on the list price of $7.00 will be available to them. Only one copy per member is offered at the discount rate, the charge for additional copies being $7.00.

ASCE ENGINEERING SALARY INDEX

Consulting Firms

City	Current	Last Quarter
Atlanta	1.11	1.11
Baltimore	1.11	1.11
Boston	1.15	1.13
Chicago	1.30	1.26
Denver	1.22	1.19
Houston	1.12	1.08
Kansas City	1.14	1.14
Los Angeles	1.16	1.16
New York	1.20	1.17
Pittsburgh	1.05	0.93
Portland (Ore.)	1.15	1.15
San Francisco	1.19	1.17
Seattle	1.06	1.07

Highway Departments

Region	Current	Last Quarter
I New England	0.91	0.85
II, Mid. Atlantic	1.17	1.17
III, Mid. West	1.25	1.15
IV, South	1.09	1.07
V, West	1.00	0.97
VI, Far West	1.15	1.15

Figures are based on salaries in effect as of May 15, 1958. Base figure, the sum of Federal Civil Service, G. S. Grades 5, 7, and 9 for 1956, is $15,930.

SOCIETY AWARDS AND FELLOWSHIPS AVAILABLE

DANIEL W. MEAD PRIZES: *1959 contest closes May, 1, 1959. See 1958 Official Register, page 134; September 1958 issue of CIVIL ENGINEERING, page 78.*

FREEMAN FELLOWSHIP: *1959-1960 award closes March 1, 1959. See Official Register, page 144; January 1959 issue of CIVIL ENGINEERING, page 77.*

ERNEST E. HOWARD AWARD: *1960 award closes Feb. 1, 1960. See Offical Register, page 133; September 1958 issue of CIVIL ENGINEERING page 80.*

ASCE RESEARCH FELLOWSHIP: *1959 award closes March 15, 1959. See January 1959 issue of CIVIL ENGINEERING, page 80.*

Reclassification of Member Grades Voted

A proposal for regrading ASCE member classifications, which went to the membership for ballot on November 21, has been approved by a ten-to-one vote. The balloting in the form of an enabling constitutional amendment closed on January 23, and the votes were counted at Society headquarters on January 26. The results were 16,171 votes favoring the change and 1,712 votes opposing it.

Several major changes are provided in the reclassification proposal. The entering membership grade designation will be Associate Member, and all present Junior Members will automatically become Associate Members. Persons who are currently Associate Members. will automatically become Members. Admission to the top, or Fellow, grade of membership will be by transfer only from the Member grade.

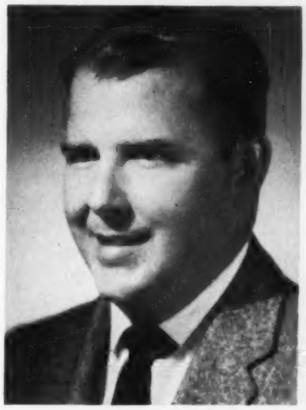
Debated over the years as a possible way to strengthen the Society's membership, the present reclassification proposal goes back to 1956, when the Board appointed a ten-man Task Committee on Classification of Members, headed by former Vice President Frank L. Weaver. The committee's interim report to the Board at Buffalo in June 1957 was printed in full in the July 1957 issue of CIVIL ENGINEERING (pages 81-82) for review and comment through the Local Sections. At Portland, in June 1958, the Board accepted the report of the Task Committee, as printed in the July issue, with minor changes in wording and a change in the name of the proposed top grade of member to Fellow.

The objective of the changes is explained by the Task Committee on Classification of Members in the November 1958 issue (page 91). Members of the Task Committee, in addition to Mr. Weaver, were Randle B. Alexander, Don M. Corbett, Clarence L. Eckel, W. S. LaLonde, Jr., Mason C. Prichard, John P. Riley, Thomas C. Shedd, Lowber D. Snow, and Graham P. Willoughby.

Members are asked *not* to inquire concerning their new grade designation. Details of the change-over will be announced as soon as they can be made available.

Daniel Mead Student Prize Goes to William G. Benko

William G. Benko, J.M. ASCE, weights engineer for North American Aviation, Inc., at Los Angeles, Calif., is the 1958 winner of the Daniel Mead Prize for Students for his essay on "Ethical Aspects of Current Practices in the Recruitment of Graduating Engineers." Mr. Benko wrote his prize-winning paper in his senior year



William G. Benko

at the University of California, where he graduated in 1958 with the bachelor of science degree in civil engineering. Mr. Benko's earlier studies at the University of Colorado, where he majored in chemical engineering, were interrupted by several years of service in the U. S. Air Force. In 1955 he entered the University of California as a civil engineering student, and was a member of the ASCE Student Chapter there.

The prize, consisting of a certificate and cash award of $50, will be presented to Mr. Benko during the ASCE Los Angeles Convention this February.

No Junior Member award of the Daniel Mead Prize was made in 1958.

Research Prizes to Be Presented at Los Angeles

One of the pleasant features of the forthcoming Los Angeles Convention will be the presentation of the Society's 1958 Research Prizes to four of the five winners. One recipient—**Dr. Ray Mindlin,** of the Columbia University Civil Engineering Department—will receive his prize later in New York at a Metropolitan Section meeting. Dr. Mindlin won the award for his research in determining the dynamic response of structural elements.

On hand for the Los Angeles ceremonies will be:

Dr. John W. Clark, of the Engineering Design Division of the Alcoa Research Laboratories, New Kensington, Pa., who is being honored for his research in analyzing and testing metal beams.

Dr. Hans A. Einstein, professor of mechanical engineering at the University of California, who will receive his award for research in the transportation of sediment by flowing water.

Dr. Warren A. Kaufman, professor of sanitary engineering at the University of California, who is receiving his award for research in treating radioactive waste.

Dr. Ivan Viest, bridge research engineer for the American Association of State Highway Officials, Ottawa, Ill., who is being cited for his research in designing reinforced concrete beams and columns.

The prizes consist of a cash award of $100 each and appropriate certificates.

International Congress on Applied Mechanics

Although the Tenth International Congress of Applied Mechanics is over a year in the future, prospective authors are urged to be thinking about their papers now. The congress will be held in Stresa, Italy, August 31 through September 7, 1960.

In addition to a number of invited general lecturers, there will be two technical sessions divided into two sections: (1) fluid dynamics (hydrodynamics and aerodynamics), and (2) mechanics of solids (rigid body dynamics, vibrations, elasticity, plasticity, and theory of structures).

A Program Committee will make selections from the papers submitted. Abstracts of papers (preferably not to exceed two double-spaced typewritten pages) should be submitted in four copies to the Secretary of the International Committee before January 1, 1960. To facilitate the work of the committee it is recommended that abstracts be in two of the official congress languages (English, French, German, and Italian). The address is Professor Mekelweg, Secretary, International Committee, Applied Mechanics Congress, Delft 2, Netherlands.

ASCE Membership as of January 9, 1959

Members	10,267
Associate Members	14,521
Junior Members	17,059
Affiliates	76
Honorary Members	44
Total	41,967
(Jan. 9, 1958	40,358)

The Younger Viewpoint

The Voice of the Committee on Junior Member Publications

Committe on Junior Member Publications

Milton Alpern, Chairman; 3536 Northview Ave., Wantagh, L. I., N. Y.

Zone I	Zone II	ZONE III	Zone IV
Louis K. Walter, Jr. 320 Market Street Kenilworth, N. J.	Raymond S. Gordon State Planters Bank Building Richmond, Va.	Water D. Linzing 4751 No. Paulina Chicago 40, Ill.	Rodney P. Lundin 9744 Quakertown Ave. Chatsworth, Calif.

This month, this column is edited primarily by the committee member from Zone I, Louis K. Walter, Jr.

What is the "younger viewpoint"?

This question, taken literally, can be pointed toward either this page and what it represents, or what the feelings of the young engineers are with regard to various aspects of engineering and to life today.

The answer to the first part should be fairly obvious to readers of this page. It has been in existence for several months with the purpose of publishing the views of young civil engineers on whatever question or topic they may choose to express themselves. A "crying towel" type of column is to be avoided, although it must be agreed that it is much easier to write a letter when you have a gripe to air than one regarding some general topic. This is not meant as a criticism of such letters but they do seem to predominate.

Neither is this page to be a facility for the publication of the opinions of a select group of representatives and their chairman. Their aim is to reflect *your* opinion.

Which brings us to the second meaning of the original question. What is the "younger viewpoint" if nobody expresses an opinion or feeling with regard to topics and problems of our profession? It is extremely difficult to profess to be a voice of a certain group when that group does not express itself.

The above was an unsolicited contribution. Contributions are gratefully accepted.

In an attempt to stimulate the interest of the young engineer, especially the recent graduate, in joining ASCE, the Junior Member Forum of the Metropolitan Section is weighing the merits of having an organizational meeting early in the fall. Its purpose—to bring together the potential Junior Members of the Society on a somewhat informal basis a short time after their graduation. The form considered has been a beer-and-pretzel type of affair with some kind of non-technical entertainment, such as recent World Series films, as an added lure. Inasmuch as the Forum has never attempted this type of meeting, it is anxious to learn of results and opinions from other Sections.

In case it has slipped your mind, the deadline for entries in the **Daniel W. Mead competition for papers on engineering ethics is May 1, 1959.** Complete rules and details of the award procedure are available on page 134 of the 1958 ASCE Official Register. There are separate prizes for Junior Members and Student Chapter members of the ASCE. The subject for this year is "The Responsibilities of the Engineering Employee to his Employer."

(**Food for thought:** It has been brought to our attention that the response to this competition has been something less than overwhelming. What can be done to make it more attractive? Some suggestions that come to mind: increase the monetary value of the prize; in lieu of selecting a specific topic each year it might be better to write on the general theme of ethics. What do you, the person who is eligible to compete for this prize, feel would make the competition more attractive?)

One of our Canadian neighbors, Charles J. Purcell, J. M. ASCE, of Montreal, has written us a letter of protest about the Engineering Societies Personnel Service. Perhaps some of the readers who have dealt with private agencies can give us the results of their experiences regarding fees and services. Some six years ago your editor for this month had occasion to contact the ESPS and, contrary to Mr. Purcell's experience, his impression was very favorable. Mr. Purcell's letter follows:

"I am writing to you concerning a peeve of mine which I would like to see explained and discussed in the pages of CIVIL ENGINEERING. Since I think the subject is of most interest to the Junior Members I am going to institute my campaign of protest, starting with 'The Younger Viewpoint.'

"My complaint is the method of advertising and financing of Engineering Societies Personnel Service, Inc., as carried in the pages of our magazine. I feel that the way the majority of 'Positions Available' are advertised, forcing interested persons to sign up with the Engineering Societies Personnel Service, compels them to pay out the exorbitant amount of 4 percent of an annual salary. The effort put out by the Service is utterly inadequate considering the charges levied.

"I have written to the Executive Secretary and was told that ASCE, in order to retain it's tax-free status, cannot operate an employment service. This is the reason why ESPS was set up. I have no complaint regarding having an independent service but would like to have its operation on a more justifiable basis.

"I feel that if the other Junior Members *knew* about this they would also resent it. I base this feeling on the fact that I knew nothing of it until I had occasion to answer an advertisement and then, instead of receiving further details as I would expect from a reputable publication, I received forms to fill out and contract to hand over 4 percent of my

salary in order to get the name of the advertiser. Which, by the way, I did not do.

"There is no notice on the page showing these requirements except a fine print type saying 'agrees to pay a fee at rates listed by the Service.' Do you consider that the rates listed are justified by the service rendered as would be expected in an ethical professional magazine?

"If the rates charged are *said* to be necessary to operate, then the Service must either be very ineffective or very inefficient and both cases require major surgery.

"Thats my viewpoint!!!!"

[*Editor's Note: ESPS is a non-profit corporation fostered by the Founder Societies to provide an employment service for their members. Its fees are established to pay the cost of service requested by thousands of engineers and agencies each year. The 4 percent charged by ESPS compares with a minimum of 5 per cent (substantially more in the Middle West) by commercial agencies. ESPS encourages employers to pay the fee, but this varies with supply and demand.*]

Alfred Noble Prize Goes To Electrical Engineer

The Alfred Noble Prize for 1958 has been awarded to Ghaffar Farman-Farmaian, of Tehran, Iran, a young electrical engineer and associate member of the American Institute of Electrical Engineers. The award was made for his paper, "General Analysis and Stability Study of Finite Pulsed Feedback Systems," which appeared in Vol. 22 of the AIEE Transactions. A native of Tehran, Mr. Farman-Farmaian received his undergraduate education in England, graduating from Loughborough College in 1951. He took his master of science in electrical engineering from the University of Illinois in 1953 and his doctorate from the University of California in 1958.

Established in 1929 in honor of the late Alfred Noble, Past-President of ASCE and the Western Society of Engineers, the prize is a joint award of the Founder Societies and the Western Society of Engineers. It is administered by ASCE. The award is made annually to a young member of one of the cooperating societies for the best paper published in one of their journals.

Collective Bargaining— The ASCE Attitude

In a recent exchange of correspondence, a member of the Society advocated an article in Civil Engineering that would "be detailed enough so that our membership will thoroughly understand the position ASCE has taken with respect to professional employee bargaining groups". It is hoped that this article will serve the purpose.

Astonishing statements are heard, or read, from time to time, regarding the position of ASCE with respect to collective bargaining by engineering employees and what the Society has done about it.

Not long ago it was rumored that the official attitude had once been to encourage and assist engineers to become members of labor unions. Such a statement could not be farther from the truth. From the inception of the Society's interest in problems of unionization and collective bargaining, there have been more than 20 years of constructive effort wholly contrary to such a concept. The fundamental desire throughout has been to enable engineers to avoid inclusion in unions of nonprofessional employees and to permit them free choice of action as to whether they wanted any part of collective bargaining.

Another erroneous statment is to the effect that ASCE has sponsored bargaining groups. It has not. The Society has furnished information and advice as to how a group of professional employees might proceed to organize a bargaining unit of their own if they so desired.

This action originated in the early 1940's when, under the Wagner Act, engineers were sorely harassed by existing labor unions and, in many instances, found themselves swept into unions against their will and subjected to grave abuse. The situation became intolerable. Yet none of the major engineering societies was doing anything to help.

After careful consideration, ASCE set forth a program under which a small committee could be organized by any Local Section in whose area there was a recognized need for action. The committee, with the benefit of information furnished by the Society, could help toward developing an appropriate unit of professional employees for certification by the National Labor Relations Board. The first step consisted of an invitation to all interested employee engineers in the area, whether or not members of ASCE, to join together in an independent organization. That organization elected its own officers and could then proceed to become an active collective bargaining group. Once the larger organization was established, the Local Section committee had no further purpose. ASCE had no connection with the ultimate group. The sole objective of the Society was to assist professional employees who were in distress and had no one to whom to look for help. Enactment of the Taft-Hartley Act greatly simplified the situation, and for many years there has been no occasion for any Local Section to serve in the manner described.

In this connection it is to be noted that neither the Society nor a Local Section can take any part in the activity of a collective bargaining group, even if it so desires. A bargaining unit must be composed solely of employees and, since ASCE membership includes both employers and employees, the NLRB would refuse certification to any unit that was even in part supported by the Society.

The Society's official policy was formulated by the Committee on Employment Conditions and adopted by the Board of Direction in 1946. Published many times, it reads as follows:

"(1) Any group of professional employees, who have a community of interest and who wish to bargain collectively, should be guaranteed the right to form and administer their own bargaining unit and be permitted free choice of their representatives to negotiate with their employer.

"(2) No professional employee, or group of employees, desiring to undertake collective bargaining with an employer should be forced to affiliate with, or become members of, any bargaining group which includes nonprofessional employees, or to submit to representation by such a group or its designated agents.

"(3) No professional employee should be forced, against his desires, to join any organization as a condition of his employment, or to sacrifice his right to individual personal relations with his employer in matters of employment conditions."

That policy later was adopted by Engineers Joint Council. It is the policy on which the professional employee provisions of the Taft-Hartley Act were based as the result of action by the EJC Labor Legislation Panel with ASCE taking the lead by request. Without change, it still is ASCE's official statement of policy.

Division Doings

Construction Division

The Construction Division has a new look these days, following complete overhaul of its administrative and technical committee structure in a move to bring the Division's "standing in accomplishment on a par with its ranking in size." With 8,200 members, the Division is ASCE's second largest. Ten new committees have been formed, and two of eight existing committees have been discontinued. The newly formed executive committee is headed by Walter L. Couse, former vice-chairman. The only other holdover member is Alexander Brest. Three new members have begun their duties. They are Lyman D. Wilbur (vice-chairman), Joseph F. Jelley, Jr., and Michael N. Salgo (secretary).

An important recent Construction Division activity was co-sponsorship with the Structural Division of ASCE's part in the Fourth National Construction Industry Conference, held in Chicago in December. Other societies taking part were the American Institute of Architects, the Associated General Contractors of America, and the Building Research Institute. The Armour Research Foundation of Illinois Institute of Technology was host to the two-day gathering, which was attended by some 300 architects, engineers, social scientists, and builders.

The prime topic of discussion was "Human Needs in Cities of the Future." The engineering group emphasized the need for new and more flexible building forms. The engineering program was highlighted by the presence of Edward Torroja, M.ASCE, internationally known structural engineer and director of the Instituto Tecnico de la Construccion in Madrid. Mr. Torroja also advocated greater daring in the use of structural shapes. In the opinion of the builders represented on the program, "the new shapes can be built, but at a price."

Hydraulics Division

Plans are shaping up for the Hydraulic Division's eighth annual conference, set for Fort Collins, Colo., July 1-3. The conference co-hosts will be the Colorado Section and Colorado State University. The three-day technical program will include papers on various hydraulic subjects and a tour of the Hydraulics Laboratory at Colorado State. Two valuable inspection trips have been planned for the days immediately preceding the conference. On June 29 there will be an opportunity to visit the Bureau of Reclamation's Hydraulics Laboratory in Denver, and on June 30 there will be a guided tour of the Bureau's Colorado-Big Thompson project, one of the most extensive irrigation and power projects in the state.

Housing accommodations for both individuals and families will be available at reasonable rates in new university dormitories. The interests of the ladies and children are being kept in mind. With some of the most beautiful country in the United States and many recreational facilities in the Fort Collins area, the Division is rightly urging engineers to combine attendance with a family vacation trip. Persons wishing to reserve a mountain cabin, should write to the Housing Committee, Hydraulics Conference, Civil Engineering Department, Colorado State University, Fort Collins, Colo. Requests for reservations should be made early because of summer tourist demand for cabins.

Highway Division

One of the objectives of the Highway Division's Committee on Increasing Highway Engineering Productivity is to assist engineering educators in their highway engineering courses by seeing that they are informed of new methods and devices. With this aim in mind, the Division recently polled 126 engineering schools and colleges. The questionnaires, which sought information on a wide range of teaching practice, will be analyzed to determine the committee's initial step.

Pipeline Division

The Pipeline Division is calling for volunteers to work on three new committees, which have been formed from the former Committee on Pipeline Design, Specifications and Operating Standards. The three new committees will investigate and correlate studies in pipeline design and economics, pipeline installation, and pipeline operation and maintenance, with the objective of disseminating civil engineering information to those engaged in the transportation of crude oil products, natural gas, water, and solids. In order to provide a broad base for committee activities, interested members are urged to return the form provided in the January issue (page 96).

Fourth Congress on Applied Mechanics

As ASCE representative on the U. S. National Committee on Theoretical and Applied Mechanics, R. E. Fadum, head of the civil engineering department at North Carolina State College, reports that plans are underway for the Fourth U. S. National Congress on Applied Mechanics. The congress will be held on the Berkeley campus of the University of California, June 18-21, 1962. Research workers in the theoretical and applied mechanics of solids and fluids are invited to submit papers for consideration by the Editorial Committee. Details and deadlines will be announced later. Prof. R. M. Rosenberg is chairman of the Editorial Committee.

The general congress chairman will be Prof. W. W. Soroka. Inquiries about the congress should be directed to Prof. W. Goldsmith, Secretary, Division of Mechanics and Design, University of California, Berkeley 4, Calif.

Pipeline Division's Task Committee on Pipeline Location, shown at recent organizational meeting, includes (in usual order) James C. Faulkner, supervisor of Drafting Division, Texas Eastern Transmission Corp., Shreveport, La.; John F. Schaffer, chief civil engineer, El Paso Natural Gas Company, El Paso, Tex.; Chairman Earnest O. Scott, reconnaissance engineer, Service Pipe Line Co., Tulsa, Okla.; Prof. Milton O. Schmidt, University of Illinois; and Robert H. Dodds, project engineer, Gibbs & Hill, New York, N. Y.

Project: Queens Anchorage, Throgs Neck Bridge, New York City
Contractor: Steers-Snare, *a joint venture*
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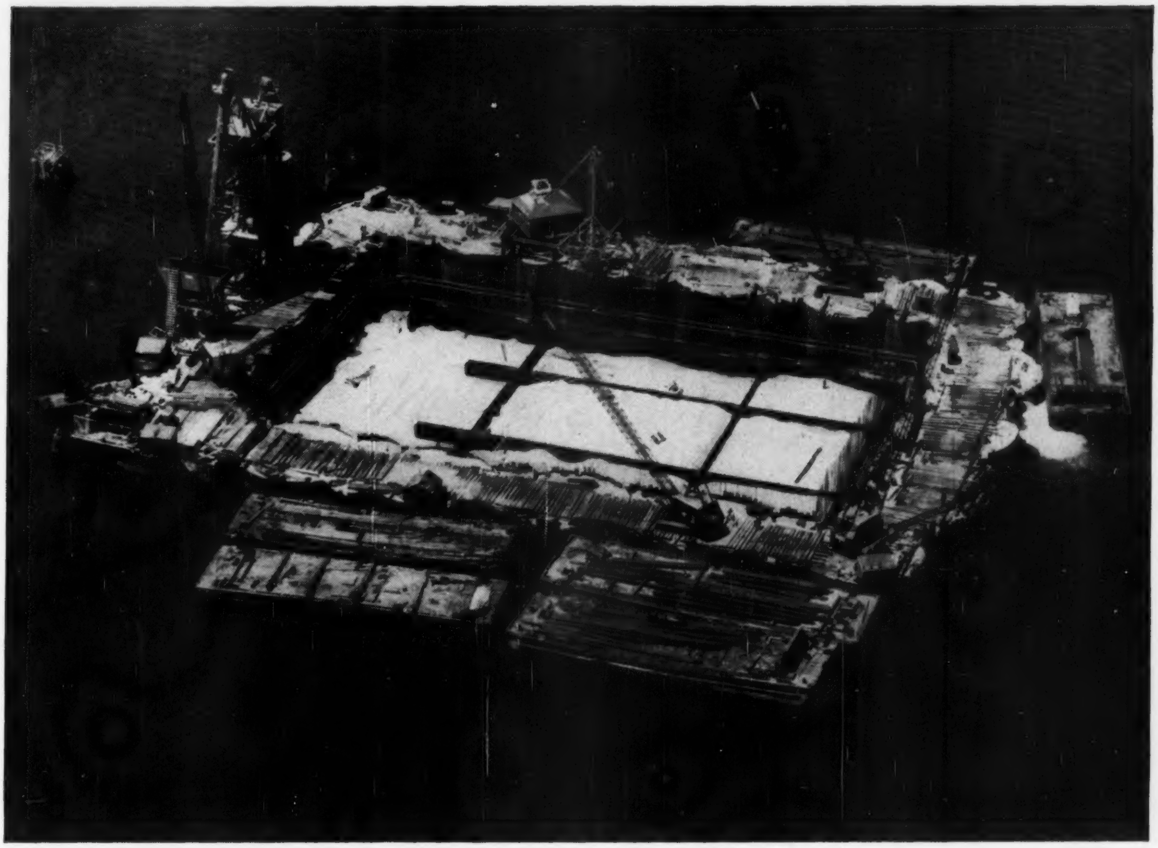

Sinking of huge bridge caisson speeded after wellpoints...

Dewater Man-Made Island 30 ft Below River

In order to sink this giant caisson a cofferdam-enclosed sand island was required. (See photo). Confident that wellpointing would result in a time and money-saving operation, Steers-Snare built the island not up to river level (which was the preliminary plan) but 25 ft below.

• **This greatly reduced the yardage of sand fill, thereby eliminating additional excavation later on. However, Griffin** engineers were confronted with a difficult dewatering job, since investigations indicated many unusual problems of soil mechanics, hydraulics and stability.

• **Solution? A specially designed Griffin wellpoint** system which attained absolute control of ground water and uplift pressure and insured the stability of the cofferdam.

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NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

In unanimous balloting, the **Juneau Branch** of the **Alaska Section** has elected the following new officers: R. J. DeLa-Hunt, president; Hurff Saunders, vice-president; Ron Mayo, secretary-treasurer; and Glade W. Roberts, assistant secretary-treasurer. Thomas Stewart, a local attorney and former secretary of the Alaska Constitutional Convention, elaborated on the aspects of the new State Constitution that concerns engineers.

At a recent **Lehigh Valley Section** meeting, the new president, John M. Adams, presented the outgoing president, Prof. Robert De Moyer, with a certificate of appreciation for his outstanding leadership of the Section during the UEC fund campaign—the Section was second in the nation to fulfill its quota in the campaign. Other Section officers are Walter D. Myers, second vice-president; Lawrence G. Adams, secretary-treasurer; and Edward Mark Cummings, who will serve a second year as first vice-president. Speaker for the evening, Hugh Moore, Jr., community architect, outlined features of home design that add charm and warmth to a house.

The recent annual meeting of the **Vermont Branch** of the **Maine Section**, a combination dinner-business meeting, was highlighted by a talk by Fozi Cahaly, of the Boston firm of Fay, Spofford & Thorndike. Mr. Cahaly gave an illustrated talk on the proposed changes to make a complete treatment plant out of the present primary plant, the St. Albans Sewage Treatment Plant. Officers elected for the new year are Stephen Knight, president; Kenneth Kidd, vice-president; and Gordon Pyper, secretary-treasurer.

Officers for the coming year recently elected by the **Miami Section** are Herbert S. Saffir, president; Howard Post, vice-president; Walter E. Dinn, secretary and Christopher Tyson, treasurer.

The following slate of officers for 1959 were announced at a recent meeting of the **Little Rock Branch** of the **Mid-South Section:** J. W. Courter, president; Margaret Peterson, vice-president; and Reid Beckel, secretary-treasurer. Guest speaker, Dr. Raymond E. Edwards, compared educational systems in the United States, Great Britain and Russia. The **Memphis Branch** unanimously elected W. D. Painter, president; R. E. Hagenhoff, vice-president; and J. B. Fryar, secretary-treasurer, at a recent meeting. Paul M. Enright, of International Engineering, and the evening's speaker, gave an illustrated talk on the Southern Pacific Railroad's Great Salt Lake Crossing begun in 1953. He covered the problems faced on this tremendous project and many of their unique and original solutions. Officers elected for 1959 by the **Vicksburg Branch** are: Russell C. Baker, president; Frank B. Campbell, vice-president; and William E. Strohm, secretary-treasurer.

Franklin Sunn (left), past president of the Hawaii Section, congratulates incoming president Edward J. Morgan. Other new officers are Russell Smith, third vice-president; Wayne Duncan, first vice-president; Paul Liu, secretary; and Richard Cox, treasurer.

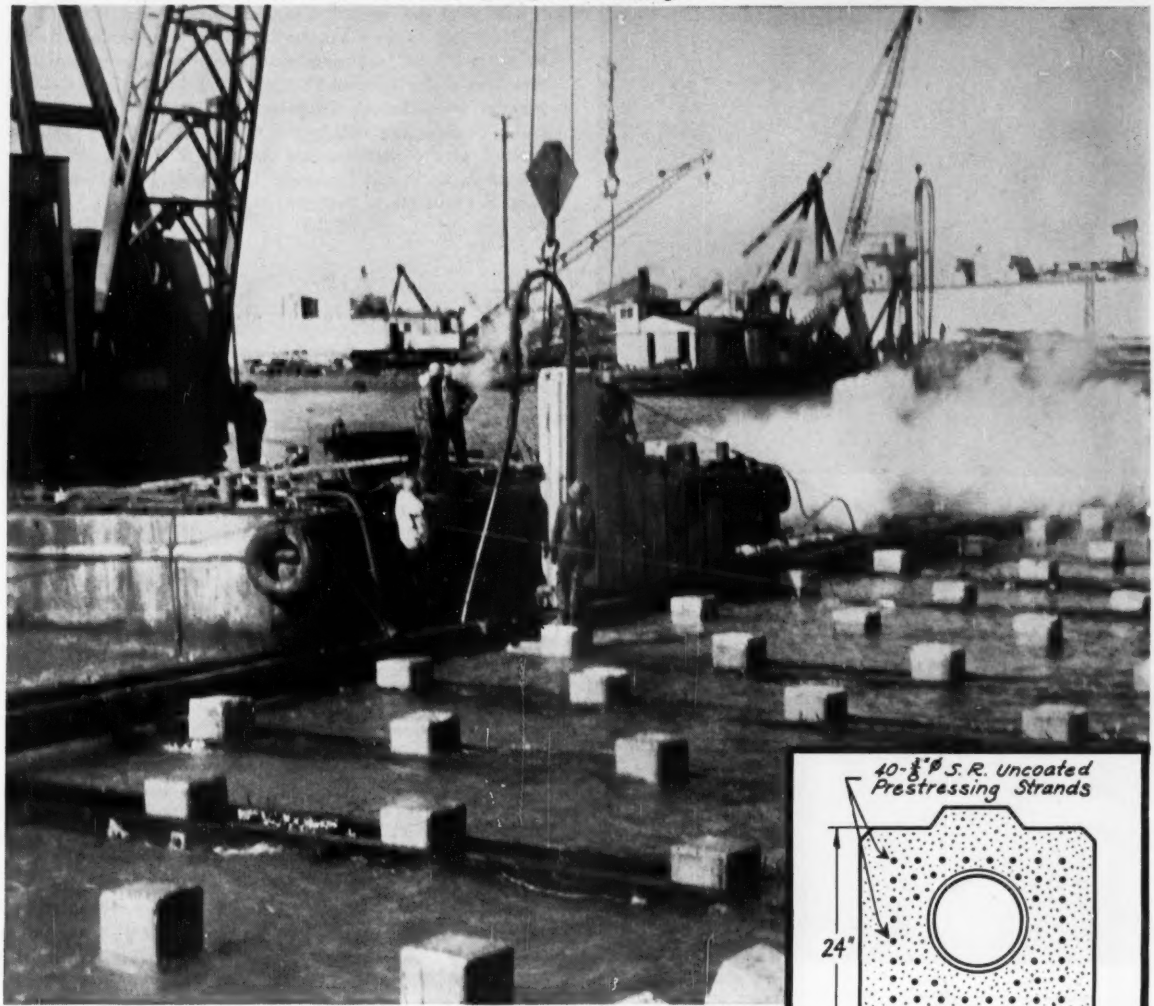
The Central Ohio Section installs 1959 officers at its annual meeting. In usual order are: Charles H. Corning, secretary-treasurer; Robert F. Baker, first vice-president; O. H. Jeffers, president; and S. W. Dudley, second vice-president. Guest speaker, Dr. William Ewing, associate director of WOSU Radio and TV, spoke on Giving Education the Air.

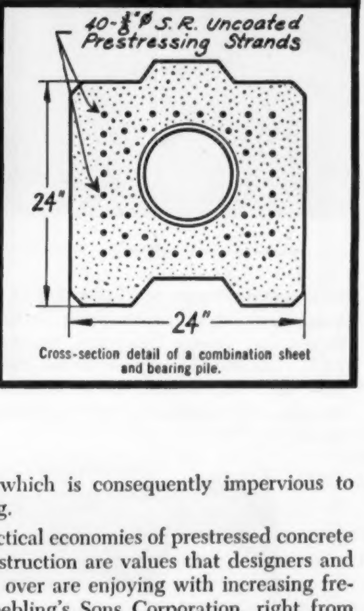
New officers of the **Mohawk-Hudson Section** are: Cliff S. Barton, president; Haaren A. Miklofsky, first vice-president; William G. Wilkie, second vice-president; R. Vincent Milligan, secretary; and Erhard E. Dittbrenner, treasurer.

The 1958-1959 season of the **Philadelphia Section** was inaugurated by a recent well-attended joint meeting with the Metropolitan-Philadelphia Chapter of the American Public Works Association. Walter Douglas, partner in the New York consulting firm of Parsons, Brinckerhoff, Hall and Macdonald, spoke on regional transportation. Emphasizing transportation as the most important, significant factor in municipal and regional development, Mr. Douglas decried the traffic congestion problem common to all metropolitan areas, stressing the need for an overall system to alleviate the nightmare. A symposium on the general subject, "Prestressed Concrete—Its Uses and Methods of Production," marked another meeting. The three speakers—Frederick C. Lowy, Philip Grennan, and L. C. Petersen—presented various phases of the relatively new and fast-growing concept of reinforced concrete design.

A special feature of Pittsburgh's year-long 200th anniversary celebration will be

Here piles are being driven through a template to assure proper alignment and fitting.





Cross-section detail of a combination sheet and bearing pile.

Prestressed Concrete Piles For C&O Railway Bulkhead

Part of the new Chesapeake and Ohio Railway facilities at Newport News, Virginia, is a 650 ft long bulkhead and relieving platform. Built by the Tidewater Construction Corporation of Norfolk, Virginia, it consists of interlocking prestressed piles 63 ft long and 24 inches square. These function simultaneously as sheet and bearing piles. In addition, some 453 bearing piles 20 inches square and varying in lengths from 60 to 65 ft are going into the finished project.

Among the benefits of prestressed piles—currently being taken advantage of by many State Highway Departments and State Maritime Commissions are: ease of handling and the ability to withstand driving shocks without cracking. Prestressed piles can be easily carried by attachments at one or two points on the pile, while other concrete piles of like dimensions would require three or four lifting points. Most important, prestressed piles can withstand *severe* driving conditions without cracking or spalling. This quality results in a crackless pile which is consequently impervious to freezing and thawing.

The great and practical economies of prestressed concrete in all manner of construction are values that designers and builders the country over are enjoying with increasing frequency. John A. Roebling's Sons Corporation, right from the introduction of this method in this country, has done important and informative work on all its phases; design, prestressing elements, casting beds and development of prestressed strand. We invite inquiries of any "prestressed" nature and will be happy to enlarge your knowledge and work with you in every way possible. Please address your requirements to Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

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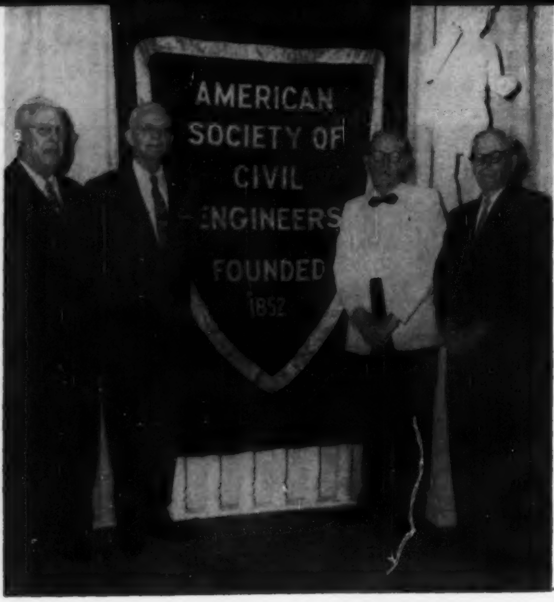
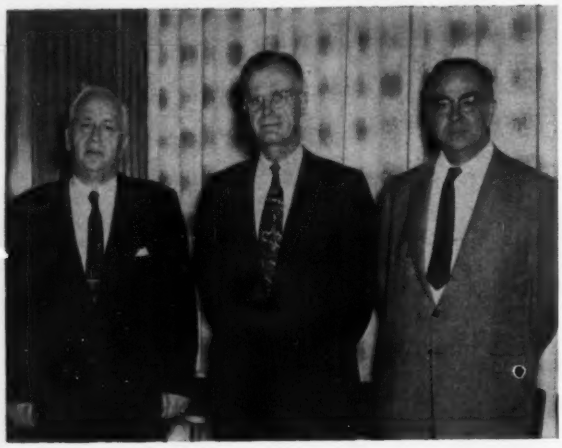


Highlight of the annual dinner meeting of the Puerto Rico Section, held in the Governor's Room of the Condado Beach Hotel, San Juan, in December, was the reunion of four Life Members of the Section. They are, from left to right, Colonel Manuel Font, Rafael Gonzalez, Etienne Totti, and Robert Auld. Section now has seven Life Members. New officers, elected at the meeting, are Antonio R. Torres, president; Hector A. Deliz and Fernando Torrent, vice-presidents; and Juan R. Figueroa, secretary-treasurer.

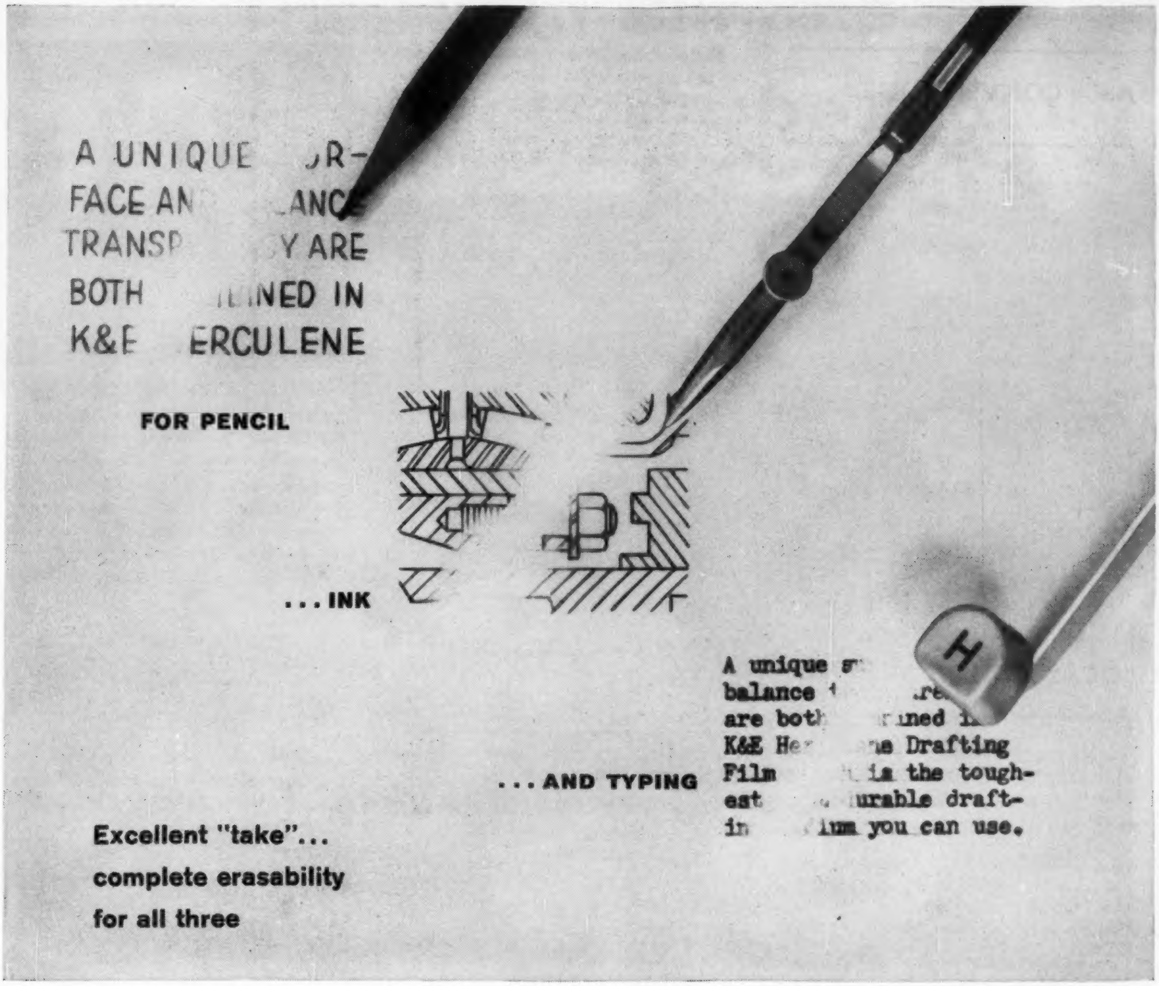


New St. Louis Section officers, elected at recent annual meeting, are, in usual order, Henry S. Miller, president; Erwin E. Bloss, first vice president; and Earl R. Salveter, second vice president. Also elected were Irwin A. Benjamin as secretary and O. Fred Nelson as treasurer.

a joint meeting sponsored by the **Pittsburgh Section** and the Pittsburgh Bicentennial Association on March 24. As part of the program's emphasis on the role of science—what it stands for and what it is doing—Executive Secretary William H. Wisely will speak to a group of high school students about civil engineering as a career and profession. In the same mood, sound movies of several important civil engineering projects and exhibits depicting the work of the civil engineer will be shown in the New Bell Telephone Company Building Auditorium in Gateway Center, at 3:30 p.m. The cocktail hour and dinner, 6 to 8 p.m., will be held at the Gateway Plaza Restaurant at $4.00 per plate. Concluding the day's activities, President Francis Friel will speak on the significance and importance of the military and civil engineer in the development of the Pittsburgh area. This part of the program will begin at 8:30 p.m. in the Bell Telephone Building Auditorium and will be open to the general public.

Five civil engineers are honored with lifetime memberships in the Society at joint dinner meeting of the Michigan Section and Student Chapters of the University of Detroit and Wayne University. Receiving their certificates are (left to right): Otto Koch, retired civil engineer for the New York Central Railroad; Edwin Pate, of Pate Hirn, Inc.; Carl Barton, retired president of Barton-Malow Contractors; and Milton Wagnitz, city engineer of Detroit. Missing is Joseph Bendt, who was on a job in Grand Rapids.

The **Chattanooga Branch** of the **Tennessee Valley Section** was host to the Section at its annual meeting in November. The exhibits, technical sessions, luncheons, and a dinner with its exceptional entertainment, made up one of the finest annual meetings the Section has had. As principal speaker Society Vice-President Paul L. Holland, although an eleventh hour replacement for President Friel, gave a forceful talk built around President Friel's inaugural address, "Our Engineering Passport," in which he pointed out the privileges and responsibilities of the profession. During the business session, Mayor P. R. Olgiati of Chattanooga outlined the political and economic situations of the past ten years



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ASCE CONVENTIONS

CLEVELAND CONVENTION

Cleveland, Ohio
Hotel Cleveland
May 4-8, 1959

ANNUAL CONVENTION

Washington, D. C.
Hotel Statler
October 19-23, 1959

NEW ORLEANS CONVENTION

New Orleans, La.
Jung Hotel
March 7-11, 1960

LOCAL SECTION MEETINGS

Central Pennsylvania—Dinner meeting at Van's Colonial Restaurant in Harrisburg, February 24 at 6 p.m.

Hawaii—Post-Convention Tour of the Islands, February 16-25. Tour headquarters will be the Reef Hotel, Honolulu. For information write, Reservations Committee, P.O. Box 8084, Honolulu, Hawaii.

Illinois—Weekly luncheon meeting at the Engineers' Club, Chicago, every Friday at 12 noon.

Los Angeles—Dinner meeting of the Sanitary Engineering Group at the Engineers' Club in the Biltmore Hotel on February 25 at 6:30 p.m.

Metropolitan—Meeting in the Engineering Societies Building, February 18, at 7 p.m.

Philadelphia—Junior Member Forum on the Need for Port Development and Desirable Objectives at the Engineers' Club on March 10 at 7:30 p.m.; meeting of the Construction Division at the Engineers' Club on March 25.

Pittsburgh—Joint afternoon and evening meeting with the Pittsburgh Bicentennial Association in the New Bell Telephone Company Building in Gateway Center, downtown Pittsburgh on March 24. A cocktail hour and dinner will be held at the Gateway Plaza Restaurant in Gateway Center at 6 p.m.

Virginia—Norfolk Branch meeting the third Monday of every month at the YMCA Cafeteria at 12 noon; Richmond Branch meeting the first Monday of every month at the Hot Shoppe Cafeteria at 12:15 p.m.; Roanoke Branch meeting the second Wednesday of every month in the S & W Cafeteria at 6:30 p.m.

TECHNICAL DIVISION MEETINGS

JET AIRPORT CONFERENCE

Houston, Tex.
Shamrock-Hilton Hotel
May 20-22, 1959

Sponsored by
ASCE Air Transport Division
Houston Branch of
Texas Section

HYDRAULICS CONFERENCE

Fort Collins, Colo.
Colorado State University
July 1-3, 1959

Sponsored by
ASCE Hydraulics Division
Colorado Section
Colorado State University

Ronald M. White (left) receives congratulations on assuming presidency of the Kansas City Section from his predecessor in office, L. W. Bremser. Other new officers are Richard O. Davis, first vice president; F. E. Bleistein, second vice-president; and Jack F. Daily, secretary-treasurer. The new Directors are A. Pearce Godley, W. R. Gibbs, and James G. Stinson.

in the Chattanooga metropolitan area that have made necessary new traffic systems, expressways, bridges and urban housing, a drama being reenacted throughout the United States.

The **Virginia Section** held its annual meeting in December. The two-day program included business and technical sessions, and a banquet and inspection trip. Among the many prominent engineers attending were Waldo G. Bowman, Paul L. Holland, Lloyd D. Knapp and Samuel B. Morris, Vice-Presidents of ASCE; Louis R. Howson and Mason G. Lockwood, Past Presidents of ASCE; and William H. Wisely, Executive Secretary of ASCE. President Francis Friel was featured banquet speaker, and Past-President William R. Glidden was toastmaster.

Participating in the Ninth Annual Highway Conference at the University of Maine—sponsored by the Maine Section, the State Highway Commission, and the Student Chapter—are (left to right) Weston S. Evans, dean of the College of Technology, and speakers John W. Leslie, chief of the New England Division of the U. S. Corps of Engineers, and Ellis L. Armstrong, Commissioner of the U. S. Bureau of Public Roads. The program covered various aspects of highway engineering and construction and progress of highway improvements in the Maine area.

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This dependable pipe is light in weight, easy to handle and install, strong and safe in service—particularly on push-pull ventilating operations. And when you make connections with the NAYLOR one-piece Wedgelock Coupling, you can set up lines quickly with just one side of the pipe in the open. **For the details, write for new Bulletin No. 59.**

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BY-LINE WASHINGTON . . . . .

Labor news affecting consulting engineers ranked high among Washington developments of interest to the profession last month.

The U. S. Supreme Court handed down two decisions of considerable importance. In one, it found that the National Labor Relations Board acted illegally in combining both professional employees and non-professionals in one bargaining unit, and without the prior approval of a majority of the professional engineers (January issue, page 83).

If professional employees of an industrial organization desire to organize and bargain collectively they must be given separate and distinct recognition. This is a prerogative which has long been accorded engineering groups under the Taft-Hartley Act, but the NLRB in the disputed case felt that the inclusion of nine non-professional employees in a professional group negotiating with an employer would not destroy the predominantly professional character of the unit. When the federal district court upheld the position of the engineers, the NLRB appealed first to an appellate court and finally to the Supreme Court, but with no success.

The second decision went against the interests of engineers. In reviewing the case of Lublin, McGaughy and Associates, the Court found that the consulting engineers, engaged in preparing plans and blueprints for a construction project of an interstate nature, were, in effect, thus part of interstate commerce and so their employees are subject to federal wage and hour regulations.

It had been argued in a brief submitted as "a friend of the court," that a consultant's activities as a designer are not actually in or closely related to the movement of commerce and that his services are of too personal and advisory a nature to be defined as commercial. The Court saw it differently. The majority opinion declared that the consultant's participation in development of an enterprise which would ultimately serve interstate commerce determined the Court's decision. The practical result will probably be an increase in the cost of engineering services where consultants have heretofore not been so concerned with the federal wage and hour laws.

The NLRB also turned down a company request to have senior project engineers excluded from an engineers' union. The company, Pennsylvania Power and Light, had contended that its senior project engineers in the Engineering and Construction Division were supervisors and therefore exempt from membership in the local, an affiliate of Engineers and Scientists of America. It claimed that because senior project engineers direct the work of project engineers and assume some management responsibilities (such as merit rating) they should not be assigned to a collective bargaining unit.

NLRB differed because, it said, if the senior project engineers were tagged as "supervisors," the organization would be top heavy with supervisors and the ratio unrealistic. "We are satisfied that the direction exercised by the senior project engineers, who have no formal responsibility beyond the project specifically assigned to them, is not of a supervisory nature," it opined.

Also of timely interest on the labor front: New salary requirements for the exemption of professional and administrative employees from the federal Fair Labor Standards Act will go into effect February 2. The revised schedule requires that, in order to be exempt from the Act's minimum wage and overtime provisions, a professional or administrative employee must be paid at least $95 a week, instead of the $75 heretofore the rule.

* * *

Uncle Sam is finding out it pays to pay well. The Civil Service Commission reported last month that the new and higher salary schedules it set up for beginning engineers last year have been instrumental in drawing more young men into federal employment. Fully 37 percent of the persons offered beginning engineering positions in 1958 accepted, compared with a low 17 percent back in 1954. Jobs paying about $6,900 to $8,200 are drawing even better (48 percent acceptance, compared to only 11 percent two years ago in 1956), and offers of top positions paying about $9,500 to $16,000 were accepted by 59 percent of the engineers approached (compared to 12 percent in 1956).

So, the gap between attractiveness of industry and government jobs has narrowed significantly. The CSC gives much credit to the 10 percent pay raise authorized by Congress last year, and a new policy of hiring high quality graduates at a Grade 7 level ($5,900).

* * *

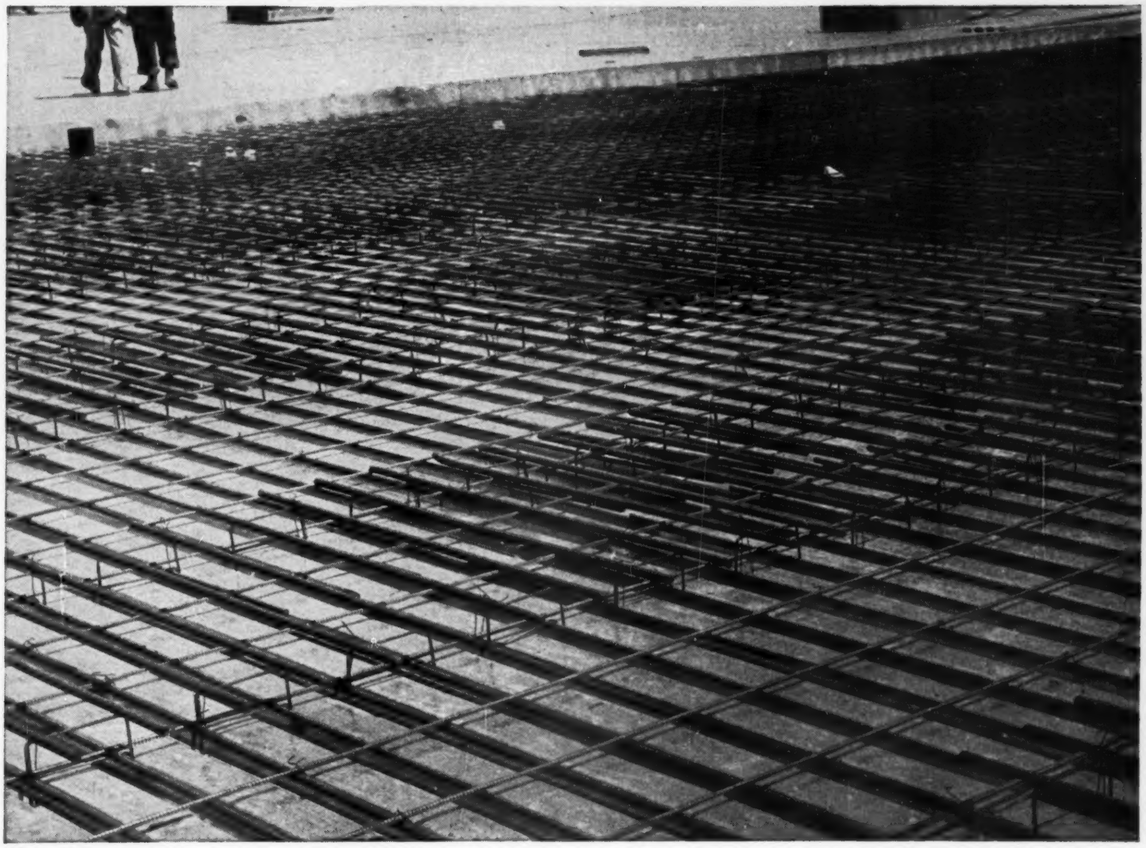
Officials of the Construction Specifications Institute here have announced a membership drive to boost membership from the present 3,200 to 5,000 by the year's end. The CSI also hopes to increase its number of local chapters from the present 31 to 50 within the year. Although the organization of specification writers is eleven years old, the last three years has seen its membership roll really skyrocketing.

* * *

The observance of "National Engineers Week" this month (February 22-28) will be kicked off with a commendatory message from the White House and followed by a barrage of radio, television, and press publicity, all designed to draw attention to the importance of the engineer in American life. A number of leading civil engineers here in Washington are lending their names and prestige to the effort.

* * *

A new Under Secretary of Commerce for Transportation was named last month. John J. Allen, Jr., a former Republican Congressman who lost his seat in the Democratic landslide last November, has accepted the post, vacated by Louis Rothschild recently. An attorney, Mr. Allen will be responsible, in the Commerce office, for administration of the Bureau of Public Roads and the new Federal Aviation Agency, the two agencies that represent the federal interest in roadbuilding and airport construction.



LACLEDE PREFABRICATED SLAB REINFORCEMENT SAVES 100,000 TIES IN NEW PLANT CONSTRUCTION

Laclede multi-rib round reinforcing bars shop welded into special prefabricated units saved hours of costly time in the construction of floor slabs for Chrysler Corporation's new St. Louis Assembly Plant.

Eighty-seven thousand of these top and bottom steel reinforcing units, each consisting of two bars up to 15′ long welded to supporting frames, were used in the construction of 485,000 square feet of flooring.

Fabricated to extremely accurate dimensions, units were easily handled and dropped into place on the metal deck. Approximately 100,000 ties were saved by the use of these special Laclede-designed units.

CHRYSLER CORPORATION ST. LOUIS ASSEMBLY PLANT
St. Louis County, Mo.

General Contractor: H. D. Tousley Co., Inc., Indianapolis
Architect: Albert Kahn,
Associated Architects and Engineers of Detroit

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SAINT LOUIS, MISSOURI ◆ Producers of Steel for Industry and Construction

These three working pictures show TD-24's on the J. W. Briggs Construction Co. job — where the contractor is building 10.5 miles of new road to make way for Cougar Dam, under construction. The scenes are on a section being carved from basalt cliffs — where TD-24 operating safety and capacity *equals* the daily yardage of *two* king-sized clutch-steered crawlers!

ONLY PLANET POWERED "24's"

give operators confidence

ON DANGEROUS DOZING LIKE THIS!

As Operator J. D. Steelman (on U-dozer rig) puts it: "The TD-24 gives a feeling of security that sure helps when you are balancing on the narrow ledge of a sheer cliff, 300 feet above the river. The TD-24's steering system, plus excellent vision, good brakes, and all the power you need give confidence that results in high work output—even in the most dangerous conditions.

"TD-24's can push full blades, full time, and can steer without dropping their load."

With Planet Power steering (controlled with 2-finger ease) come multiple safety features that build production-boosting operator confidence. Decelerate instantly with the left foot...apply equal positive braking to both tracks with the single right foot pedal...or, pull back both planetary steering levers with one hand to provide a second braking system, hydraulically actuated. Also, Control Tower Vision lets you see ahead to avoid danger zones.

It takes two king-sized clutch-steered crawlers to equal one Planet Power-steered International TD-24—on this rough, tough mountain road-building job!

Planet Power steering gives your operator full time "live" power on both tracks. Keeps the payload on the move. Gives bonus-load follow-through while turning, even with rock. Eliminates load-spilling "dead-track drag." Equalizes track speed for full-bite benching.

Measure the amazing yardage increase Planet Power-steered TD-24's give you—when blading material around curves; benching a bank or highwall; overcoming the sidedraft of uncentered loads; uprooting or dislodging "anchored" stumps or boulders. See what the high reverse of 7.5 mph means in speeding the shuttle-dozing cycle. Prove TD-24 Hi-Lo power shifting advantages for any crawler job. See your International Construction Equipment Distributor for a demonstration!

Using Hi-Lo power shifting— putting the inside track in high range and the outside one in low range—permits this TD-24 operator to turn safely, and drop the load over the cliff—without spillage on the turn!

Two TD-24's of the 5-unit fleet on this job, dozing rock over the brink of a cliff, 350 feet above the McKenzie River, in Oregon. "Our TD-24's are the units that do most of the close-edge work," states J. D. Steelman, operator of the U-dozer rig.

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NEWS BRIEFS . . .

Construction Activity Sets Dollar Record in 1958

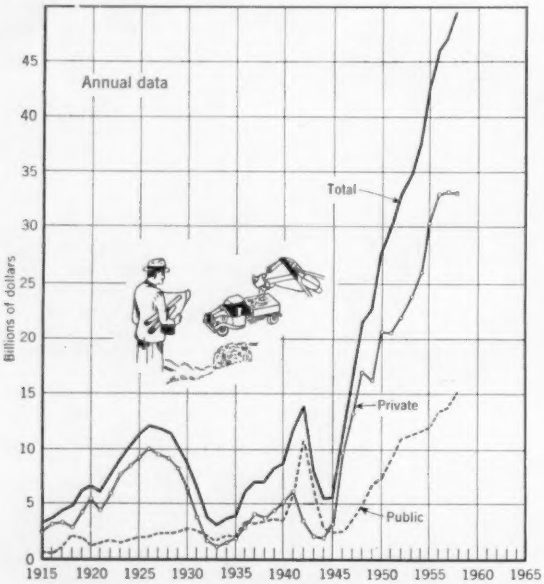
The dollar value of new construction put in place during 1958 totaled $49 billion, about 2 percent above the record $48.1 billion spent in 1957, according to preliminary joint estimates of the U. S. Departments of Labor and Commerce. The $34 billion private total matched the all-time high of 1957, and public outlays rose 6 percent to a new peak of $15 billion. Preliminary indications are that the overall physical volume of new construction put in place during 1958 (expenditures adjusted for price changes) was about the same as in 1957, or slightly below the peak of 1955.

Primarily because of a $1.1 billion drop in industrial building, 1958 was the first year since 1949 that the private total failed to show an over-the-year increase. Private spending reached new highs in 1958 for office buildings and warehouses, schools, and hospitals, and the rate of decline in store building was less than half that experienced in 1957. Construction of churches and related buildings held near the record level of 1957, as did outlays for privately owned public utilities. Strength in the latter reflected continued expansion in electric power and gas facilities, which almost offset declines in new construction by railroad and telephone and telegraph companies.

After declining in 1956 and 1957, private residential construction rose 5 percent in 1958 to $17.9 billion, but was still 4 percent below the 1955 peak. The value of work done on new dwelling units began to exceed year-earlier levels in June 1958, and the gains widened from 8 percent in the third quarter to 17 percent in the fourth quarter. Despite this improvement, the 1958 total dollar volume for new dwelling units ($13.4 billion) was about $1.6 billion, or 11 percent, less than the peak of 1955. Spending last year for additions and alterations to existing residences almost equaled the 1957 record, and the value of work done on new hotels and motels reached a new high.

Highway construction and housing (including Capehart projects for the armed services) contributed the major part of the $900 million expansion in the public total between 1957 and 1958. Highway construction advanced 8 percent to a record $5.4 billion, largely because of work put in place on the new Interstate Highway System.

Expenditures edged up to new peaks also for public schools ($2.9 billion) and for conservation and development projects ($1 billion). Administrative and service building outlays expanded (for the sixth consecutive year) to more than half a billion dollars, primarily because of work done on new post offices and other federal office buildings. Public hospital and institutional building showed another substantial rise in 1958, after reversing a five-year downtrend in 1957. However, public industrial building dropped sharply over the year, and military construction continued the decline begun in 1957.



Construction activity for 1958 breaks dollar-volume record for the thirteenth consecutive year with total outlays of $49 billion — an increase of about 2 percent over the record $48.1 billion spent in 1957. Physical volume was about the same as in 1957.

Navy Awards $21 Million Contract for Dry Dock

The Navy Bureau of Yards and Docks has awarded a joint-venture group a $21,645,000 contract for a new dry dock to be built at the Puget Sound Naval Shipyard at Bremerton, Wash. The joint venture consists of the Manson Construction and Engineering Company, of Seattle; the J. A. Jones Construction Company, of Seattle; the Perini Corporation, of San Francisco, Calif., and East Boston, Mass.; and the Osberg Construction Company, of Seattle. All work required to provide a complete facility is included in the contract, except for construction of the caisson.

The new dock, the largest of its kind ever built, will be 1,152½ ft long and 180 ft wide at the coping, with a height of 61 ft from coping to floor. It will provide 48 ft of water over the keel-blocks at high tide. Completion is scheduled for November 1961.

Pan American Air Terminal Now Under Construction

Erection of an umbrella-type roof as big as the Yankee Stadium—the covering for the new Pan American Airways passenger terminal being built at New York International Airport—was started in December by the Lehigh Structural Steel Company, fabricators and erectors for the project. The mammoth oval-shaped covering, the world's largest steel-supported umbrella, is a cantilever formed with heavy steel girders radiating in all directions from a central core of steel anchor columns, also arranged in an oval pattern. The roof will extend 124 ft beyond the walls of the three-story terminal building, which will be framed in glass and surrounded by walkways hung by cables from the roof.

The design of the terminal will permit four jet airliners simultaneously to discharge passengers under its protective roof, for the first time bringing air travelers practically to the doors of a terminal. A light and airy look will be achieved in the canopy section by minimum use of heavy steel girders. To increase the carrying capacity of these girders, which will range in length from 186 to 224 ft, they will be prestressed individually with wire cables. A 4-in.-thick concrete slab will form a roof deck over the whole area.

Engineer-architect for the $8,000,000 terminal is Tippetts-Abbett-McCarthy-Stratton, with Ives, Turano and Gardner the associate architects. The Turner Construction Company is the general contractor.

$54 Million Recommended For Ohio River Dams

At its December meeting the Board of Engineers for Rivers and Harbors recommended approval of a proposal of the Corps of Engineers' District Engineer at Huntington, W. Va., and Division Engineer at Cincinnati for the replacement of Locks and Dams 18, 19, and 20 on the Ohio River. The proposed Belleville locks and dam project would include a gated overflow dam and a fixed weir and two locks—one 1,200 ft long by 110 ft wide and the other 600 ft long by 110 ft wide. The estimated cost to the United States would be $54,400,000, plus annual maintenance and operation costs of $160,000.

Before construction can be started, the recommendation must be approved by the Chief of Engineers and the Secretary of the Army and Congress must appropriate the necessary funds.

Work Starts on New York's Narrows Bridge

Narrows Bridge, shown here in artist's sketch, will be a twelve-lane, double-deck structure joining Staten Island and Brooklyn at the entrance to New York Harbor. The 4,260-ft center suspension span will be the longest in the world.

Subsurface soil tests to obtain information essential for the design of the tower foundations of the $320,000,000 Narrows Bridge started in January. The twelve-lane double-deck bridge will connect Fort Hamilton in Brooklyn and Fort Wadsworth on Staten Island. Under a $150,000 contract, the Merritt-Chapman & Scott Corporation is driving test piles, making load tests, and taking borings at the site of the Brooklyn tower. The piles will be driven to the unusual depth of 300 ft. It is expected that the subsurface explorations will be completed in six to eight weeks. Completion of the bridge, which will include the world's longest suspension span, is scheduled for mid-1964.

The bridge, connecting Brooklyn and Staten Island at the entrance to New York Harbor, will have an overall length of two and a half miles. The 4,260-foot center suspension span will exceed by 60 ft the 4,200-ft suspension span of the Golden Gate Bridge, the world's longest existing span. The side spans will be 1,215 ft long. Vertical clearance over the channel at the middle of the suspension span will be 228 ft.

The Staten Island tower will be located about 300 ft offshore of Fort Wadsworth, while the Brooklyn tower will rest on Fort Lafayette Island about 800 ft offshore of Fort Hamilton. The towers will rise some 700 ft above the water. The lower level will be built first, with the upper level and its approach ramps to be provided when traffic warrants.

The Port of New York Authority will finance and construct the Narrows Bridge. On completion, it will be leased to the Triborough Bridge and Tunnel Authority for an amount that will cover all debt service charges on final costs. The proposal to build the bridge across the Narrows was first announced by the two Authorities in January 1955. The bridge was part of a vast program of arterial highway construction for the New York-New Jersey Metropolitan Area, recommended by the two agencies after a year-long comprehensive study. The governors and legislatures of New York and New Jersey have approved the project.

Other facilities in the joint program include the Port Authority's $182,000,000 six-lane lower deck of the George Washington Bridge, together with its expanded approaches and a new interstate bus passenger facility in Manhattan; and Triborough's $90,000,000 six-lane, single-deck Throgs Neck suspension bridge connecting Cryders Point in Queens and Fort Schuyler in the Bronx. Now under construction, these projects are scheduled for completion in 1962 and 1961.

Do You Need Funds For Graduate Study?

Availability of one thousand National Defense Graduate Fellowships for the 1959-1960 academic year is announced by the U. S. Office of Education. This year the awards will go to first-year graduate students in "approved graduate programs." The rules stipulate that the programs must be "new" or "expanded" and must assure a nationwide geographical distribution of facilities for the graduate training of college or university-level teachers. Further, the fellows must indicate an interest in teaching in institutions of higher education.

The fellowships will normally run for three years with a stipend to the individual of $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus $400 a year for each dependent. The institution will receive such payment—not to exceed $2,500 annually per fellowship—as may be determined reasonable compensation for the fellow's cost to the program.

Graduate students seeking such fellowships should apply at once to the college or university of their choice, since the awards will be administered by the institutions.

Incidentally, complete information on how to obtain graduate study funds, ranging from $200 up to $10,000, is now available in the second volume of the World-Wide Graduate Award Directory, compiled by the Advancement and Placement Institute. Over 250 universities and foundations in almost every state, plus 100 foreign universities, have supplied information for inclusion in the new volume. Volume II supplements Volume I, published in 1957, with completely new data.

Both volumes may be ordered from the Institute, Box 99 H, Greenpoint Station, Brooklyn 22, N. Y. The price is $3.00 a volume, or $5.00 for the two.

ASA Elects New Officers

J. R. Townsend, special assistant in the Office of the Assistant Secretary of Defense (Research and Engineering), has been elected president of the American Standards Association. He is a former president of the American Society for Testing Materials. Frank H. Roby, executive vice-president of the Federal Pacific Electric Corporation, Newark, N. J., has been elected vice-president. New directors are Charles W. Bryan, Jr., president of the Pullman Company, Wilmington, Del., and T. T. Miller, president of the Polymer Chemical Division of W. R. Grace & Co., of New York. Mr. Bryan was ASCE's nomination.

Announcement of the elections was made at ASA's fortieth annual meeting.

Hetch Hetchy's Cherry Valley Power Project

Granite portal for Cherry power tunnel is shown here. The 12½-ft-high by 12-ft-wide tunnel follows an almost solid granite formation in its six-mile course. The 30-in.-dia ventilating pipe emerging from the portal is suspended from slings every 20 ft along the roof centerline. The contractor devised hangers using ½-in.-dia threaded rods, which are inserted in drill holes and held by Bethlehem Pacific expanding shells used for mine roof bolts.

Since early 1958 work has been underway on the first large contracts for a $54,000,000 bond-financed hydroelectric power project for the City and County of San Francisco. The project, which will provide for the city's future needs by supplementing the Hetch Hetchy system with two new power plants, was authorized by the electorate in 1955.

Work on the power tunnel for the Cherry Valley plant is the first phase of the project. The six-mile-long pressure tunnel takes water from Lake Lloyd, stored behind Cherry Valley Dam, to a point on the Cherry River near its confluence with the Tuolumne River. The 2,400-ft drop will develop a peak capacity of 135,000 kw. The Cherry plant is scheduled for operation by July 1960.

The contractor for the Cherry Power Tunnel is Cherry Tunnel Contractors, a joint venture consisting of the Guy F. Atkinson Company (the managing partner), the Arundel Corporation, and the L. E. Dixon Company. The entire project is under the direction of Harry E. Lloyd, manager and chief engineer of the Hetch Hetchy Water Supply, Power and Utilities Engineering Bureau for the City and County of San Francisco.

Improved Drinking Water An International Aim

Engineers who have worked in foreign countries and suffered the frequent illnesses attributable to impure water will be interested in a project of the World Health Organization for coordinated international research on drinking water quality. During the past year WHO has been assembling information on research currently underway and has now made available a listing of persons engaged in such research. The publication includes an alphabetical list of scientists, with their institutions and research topics. Revision of the listing at intervals of from three to six months is planned.

To make the listing as complete as possible WHO urges all who are engaged in research on drinking water quality to make sure that their projects are known so they may be included in future issues. Projects should be reported to Robert N. Clark, Chief Sanitary Engineering Adviser, Division of Environmental Sanitation, World Health Organization, Palais des Nations, Geneva, Switzerland.

Contract for Penstocks for Niagara Power Project

The Chicago Bridge & Iron Company has received the largest single peacetime order in its history—an $11,000,000 contract to design, fabricate, and erect thirteen penstocks for the Niagara Power Project. Each is 470 ft long, with a maximum diameter of 28½ ft. The penstocks will be fabricated in the company's Greenville, Pa., plant. The work will begin in January 1959 and be completed in October 1962.

The Niagara project, which is being constructed by the Power Authority of the State of New York, will utilize water diverted from the river about three miles above the Falls. The water will move through two underground conduits into an open canal and from there to the penstocks, which will funnel it 314 ft to feed thirteen generators at the project's main power station near Lewiston.

Arctic Construction Studied at ASTM Meeting

Storage of cold air in the winter for use in the summer and the construction of buildings on fill, with an air space between the building and fill, are two possible methods of combatting some of the many problems encountered by engineers in Arctic construction. At a recent meeting of the American Society for Testing Materials, an audience of some 250 engineers heard ASTM President Kenneth B. Woods, chairman of the Civil Engineering Department at Purdue University, relate his experiences in construction in the Arctic. At the session which was co-sponsored by ASCE and ASEE, Professor Woods showed the group slides of the great North illustrating the various engineering problems existing in that area.

Supply, one of the serious problems since a good road network does not exist in much of the area, was accomplished by air transport. Large transport planes were used to deliver construction equipment to the area while personnel and smaller supplies were flown in by helicopters and sea planes.

Settlement, one of the greatest problems in the areas of permafrost, is continuously combatted by the engineers. A method of building construction was developed, which proved satisfactory in resisting settlement. Special material not subject to frost action is used as fill and is placed about 5 to 7 ft deep on the site. Piles are then driven through the fill into the permafrost. Buildings are constructed in such a way that they are raised 2 ft or more above the top of the fill. This space is left open for air flow, thus reducing the amount of heat from the building that reaches the soil.

Another method of fighting the settlement consisted of placing large pipes (from 2 to 3 ft in diameter) under the construction site. These were designed so that they caught the cold air in the winter which was stored and used in the summer to resist the thawing action. Professor Woods informed the engineers that a small house, which might sell for $2,000 to $15,000 in the States, would cost about $30,000 to $40,000 in the Arctic because of the additional measures that would be needed as well as the increased cost of construction.

Among the characteristics needed by engineers to be successful in Arctic construction are perseverance and ingenuity. New ideas are continually needed to fight the ever-present weather conditions of the North.

Pilot Plant for Sea Water Conversion Ordered

The Southern California Edison Company has awarded a contract for pilot plant equipment that will convert sea water to fresh water at its Mandalay Steam Generation Plant under construction near Oxnard, Calif. The equipment will be designed and furnished by Cleaver-Brooks Special Products, Inc., of Waukesha, Wis. Overall cost of the project, including installation and experimental operation, will be over $250,000. Test work with the new equipment, which will have an output of about 100,000 gal per day, is expected to begin near the end of the summer. Water from the plant will be used to supply some of the station's fresh-water needs. The Mandalay station is scheduled to begin operation this spring.

Cleaver-Brooks is currently building the sea water evaporator for the nation's first atomic-powered aircraft.

Brazil Steel Plant Job Goes to Kaiser Company

Early this year Brazil will start work on a huge steel plant, to be located at Piacaguera, north of Sao Paulo. Construction is being handled by the Heavy Construction Division of the Henry J. Kaiser Co., which has received a $170,000,000 award from the Companhia Siderurgica Paulista of Sao Paulo.

The plant will have an initial annual capacity of 330,750 tons of rolled steel products. It will include coal-handling facilities; 25 miles of railroad track; iron ore and limestone crushing and screening equipment; a sinter plant; 53 coke ovens; a blast furnace and two 60-ton processing furnaces; slab and plate mills and a 66-in. hot strip mill; and a 30,000-kw steam power plant.

Consulting engineering services will be provided by Kaiser Engineers, International, Inc., and Kaiser Engenharia Construcoes, Ltda.

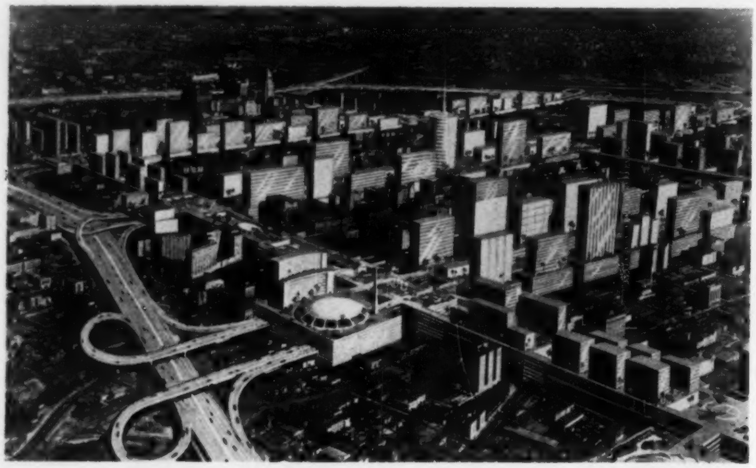
U. S. Exhibit at Moscow to Feature Aluminum Dome

Spectacular 200-ft-dia Kaiser Aluminum dome, the largest so far erected, will be a major feature of the United States cultural and industrial exhibition, to be held in Moscow, August 2-September 13. The dome will form approximately a quarter of a sphere made up of 1,100 diamond-shaped, gold-anodized panels, formed from aluminum sheet, and an equal number of aluminum struts. The dome will have a center height of 65 ft and provide a clear-span floor area of 30,000 sq ft. At the close of the exhibition, the dome and all the other buildings exhibited will be purchased by the Soviet Government. It is expected that the unique method of erecting the dome will afford the Russians an interesting demonstration of American engineering progress and industrial ingenuity. Erection of the dome will begin about April 15, under the direction of the Lydick Roofing Company, of Fort Worth, Tex. Welton Becket and Associates, of Los Angeles, are the architect-engineer for the project, and Richard R. Bradshaw is the consulting structural engineer. The geodesic dome has been patented by Buckminster Fuller.

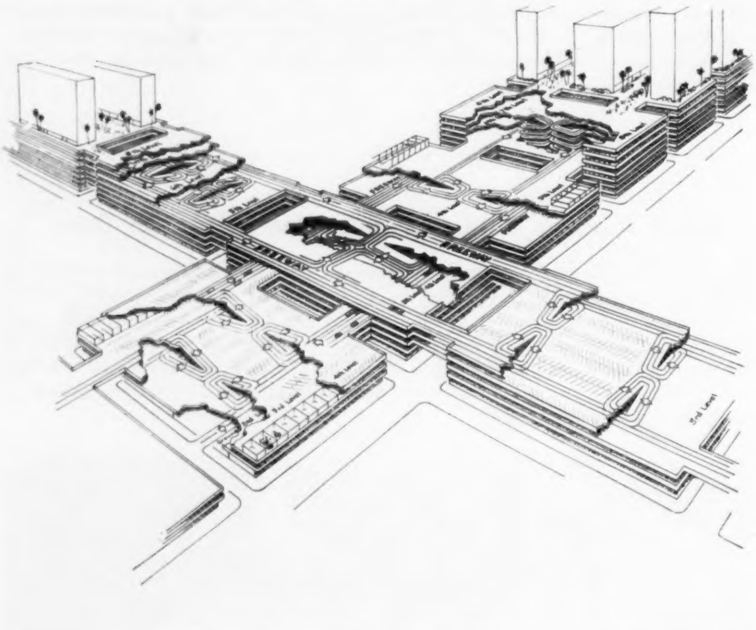
Army Awards Contract for Building Hanson Dam

The U. S. Army Corps of Engineers announces award of a construction contract for the $8,800,000 Howard A. Hanson Dam on the Green River near Seattle, Wash., to the joint-venture team of Henry J. Kaiser Company (as sponsor) and Raymond International, Inc. The project includes a rock, sand, and gravel dam with crest length of 730 ft and maximum height of 230 ft; a 900-ft-long concrete-lined tunnel, 19 ft in dia; and a 337-ft-long four-span outlet-works bridge. Completion of the entire project is scheduled for late 1962.

One Engineer's Idea of How Los Angeles Might Look



In the belief that the individual motorist should be able to take his automobile wherever he wishes E. M. Khoury, M. ASCE, consulting engineer of Canoga Park, Calif., has developed a rampless multi-story garage idea for the city-block structure that would enable a motorist to drive right to his office in the downtown area without encountering a single traffic light en route. Though Mr. Khoury has applied his plan to the Los Angeles freeways, he emphasizes that it would be equally suitable for any downtown urban area with a similar problem. The great advantage of his plan, he believes, is that it would offer minimum interference with existing utilities or streets during construction. Once the new system is in effect, it will supplement existing streets, leaving them free for bus, truck, and other slower traffic. Mr. Khoury feels his idea has sufficient merit to attract private capital for the construction.



Chicago to Improve Water Main System

A $7,750,000 water-main construction program, with the accent on improved service and fire protection, is underway in Chicago. Mayor Richard Daley announces that $1,186,000 of the Water Distribution Division's budget has been earmarked for laying fire-protection mains and completing the replacement of small-capacity mains and fire hydrants with larger units. About $750,000 will be spent in 1959 to speed the change-over of most of the 1,800 remaining 2½- and 4-in.-dia city hydrants to 4½-in. high-flow hydrants. When this project is completed by 1961, all 45,000 city fire hydrants will be uniform Chicago-type.

The city's 1959 construction program also provides for 30 miles of water mains, to be built at a cost of $4,500,000. More than five miles of these mains will be at least 24 in. in diameter.

Current outlays are part of a $39,954,000 five-year capital improvement program initiated to improve the efficiency of the city's water-distribution system. Sometime during the year first contracts will be let for the proposed $3,000,000 Southwest Pumping Station. This ultramodern new plant will have a capacity of 275 mgd.

N*G*Neare's COLUMN

R. ROBINSON ROWE M. ASCE

The February Meeting of the Engineers Club of Esseyeville convened a week later than usual so that the regulars would be back from the Dodgerville Convention, but Professor Neare didn't make it.

"Saw him last," said Joe Kerr, "at the Dizzyland Jamboree on Wednesday."

"He's still there," explained Sauer Doe, "looking for new puzzle ideas in the maze, but he asked me to carry on as Guest Professor and to ask Joe what a beer is worth in Alaska."

"Well, my Uncle Vic was there January 3 for the celebration and beer was on the house. The next evening he looked in at Buck's Quarters, where, as you said, each customer smacked down a buck or a quarter on the bar and paid that for his beer only if Buck guessed his coin. But while he watched, Buck always guessed a quarter and was right, so that's what a beer costs."

"Buck probably knew they were all cheechakos up for the celebration like

The 110'6" debutanizer shown above and the 150-ton unit (below), a 3-stage axial flow compressor, are typical Newport News products. Whether you need a hydraulic turbine, vacuum tanks or penstocks . . . bridge caissons, digesters or dryer rolls . . . you can command the services of Newport News for units of about any size or shape.

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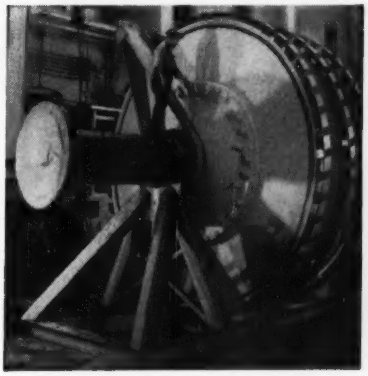

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Steel Erection for Union Carbide Skyscraper Nears Completion

Steel erection for Union Carbide's 52-story tower headquarters building nears topping out. Some 30,000 tons of structural steel are being used for the building, which will be the tallest on Park Avenue and the largest curtain-wall building ever constructed. The most intricate feature of construction was the placing of 115 steel columns into bedrock between two levels of the New Haven and New York Central Railroad tracks that handle over 500 trains a day. Erection of the steel on the 12-story section fronting on Madison Avenue behind the tower started in January 1958, and topping out by the American Bridge Division of the United States Steel Corporation is on schedule for final completion of the building in early 1960. Skidmore, Owings and Merrill are the architects, and Weiskopf and Pickworth the structural engineers. Both are New York City firms.

your Uncle Vic," guessed Cal Klater. "Sourdoughs gamble a buck now and then and usually win a free drink. Unless Buck guesses a buck now and then, they'd always play bucks and beer would be free. Suppose p is the proportion of times the sourdough plays a buck and q the proportion of times Buck guesses a buck, so that $1\text{-}p$ and $1\text{-}q$ are the respective proportions for quarters. Then the average price of a beer in cents is

$$B = 100pq + 25\,(1\text{-}p)\,(1\text{-}q)$$
$$= 20 + 5\,(5p\text{-}1)\,(5q\text{-}1)$$

Now if either p or q is 0.2, a beer is worth just 20 cents. If the sourdough plays a buck one-fifth of the time he will average 20 cents per beer, no matter how Buck guesses. Likewise if Buck guesses a buck one-fifth of the time he will collect 20 cents per beer by the same law of averages, no matter how the sourdoughs play."

"Quite so," agreed the Guest Professor. "Actually Buck does a little better by being psychic, reading high stakes in nervous eyes and the way a hand is cramped to hide iron money. Now that we understand the principle of a mathematical game in its simplest form—one item and two prices—let's try a sequel with two items and three prices.

"The items are melons, designated as Grade A and Grade B, which look exactly alike but can be recognized by plugging to reveal the inner color. Andy, the melon merchant, buys them separately in any desired proportion, paying 3 cents apiece for A and 2 cents for B, but mixes them thoroly before offering them for sale.

"The three prices are really 'purchase plans,' designated as P, Q and R, for *plug*, *quality* and *random* respectively, at the option of the patron. By Plan P, the patron selects and plugs a melon so as to determine its quality, then pays 5 cents if it's Grade A and 3 cents if it's B. By Plan Q, the patron selects and plugs until he obtains one Grade A melon, then pays 7 cents for the lot selected. By Plan R, the patron selects a melon at random and pays 4 cents. All being shrewd traders, how much should Andy be able to make on a lot of 700 melons?"

[*Cal Klaters were S. K. Rueball (Keith Jones), Ed. C. Holt Jr., and Richard Jenney. Guest Professor Sauer Doe is Marvin A. Larson. Also acknowledged are solutions of the November problem of the magic cubes from Walter J. Tudor, G. C. Vytlacil, G. Nyuss (R. M. Dodds), and John A. Tweed.*]

1959 Proclaimed Water Works Year in Illinois

Governor William G. Stratton has proclaimed 1959 Water Works Year in Illinois in tribute to the state's water works personnel during the fiftieth anniversary celebration of the Illinois section of the American Water Works Association. The proclamation also calls attention to the need for the support of planned water works development by citizens and civic leaders.

The first conference of Illinois water works men took place fifty years ago this February at the University of Illinois. Attended by 37 water works officials interested in "obtaining and conserving an abundant supply of pure water for domestic use," the meeting marked the establishment of the Illinois Water Supply Association. Five years later this group affiliated with the AWWA as its Illinois section.

The section will celebrate its fiftieth anniversary with a meeting, set for March 11-13, at the Morrison Hotel in Chicago. The three-day program will include many aspects of water supply, distribution, and treatment.

On the Ohio Turnpike, they paved with

CONCRETE... saved $7,181,898 in first cost alone!

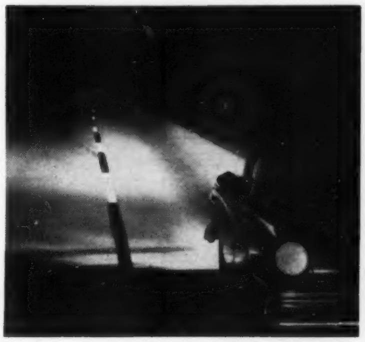
Studies of pavement designs proved in advance that only concrete could give the needed strength at so low a cost. Now records show big maintenance savings, too.

The consulting engineers on the Ohio Turnpike estimated that pavement maintenance for the first five year period would be 2 cents per square yard per year if flexible, dark colored pavement were used — and only *1 cent* per square yard per year if rigid concrete pavement were laid. Concrete was chosen for the entire Turnpike!

Twenty million vehicles have travelled it in the first two years, yet actual maintenance costs to date are only slightly more than *half the estimated amount!*

And maintenance costs will *stay* low. Concrete—because it is rigid—is the only material that has no "moving parts" to cause hidden wear. And only concrete's load-bearing strength can be figured mathematically to match future traffic—give you an expected *50 years and more* of safe, smooth driving.

All good reasons why concrete is the only thrifty way to build high-traffic-volume highways like those for the Interstate System.



Concrete's high reflectance saves as much as $40,000 a year in lighting costs for an average 10-mile expressway. Only half as many light fixtures are needed.

PORTLAND CEMENT ASSOCIATION

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DECEASED

Arthur Rich Alling (M. '23), age 70, partner in the Alling Blue Print Company of San Antonio, Tex., died there recently. Mr. Alling, a graduate of the University of Colorado, formed the company bearing his name in the early 1920's. Previously he had been employed as principal assistant engineer with the Pulaski Road Improvement District No. 10 in Arkansas.

William J. Anderson (M. '47), age 71, retired district engineer for the U. S. Bureau of Public Roads, died in Hartford, Conn., on October 20. Shortly after graduating from Union College with a degree in civil engineering, Mr. Anderson became an engineer with the Bureau. During World War II, he was on loan to the War Department as a consulting engineer to the American Military Government in Germany. In 1950, the year of his retirement, he rounded out thirty years of service as engineer for the Bureau in Connecticut.

Percy R. Banister (M. '52), age 66, consulting engineer and partner in the Banister Engineering Company, St. Paul, Minn., died November 19, in Fort Lauderdale, Fla. Mr. Banister was a graduate of the University of Minnesota and the University of California. Before founding his own company, he was construction engineer and assistant engineer for the Ramsey County engineers' office in Minnesota.

John S. Bates (M. '23), age 81, consulting engineer of Berkeley, Calif., died on September 11. A graduate of the University of Illinois, Mr. Bates spent his entire career in the field of municipal work. Prior to entering private practice in the mid-30's, he had been assistant bridge designing engineer for the California Department of Public Works. In 1934, he was state representative on the U. S. Coast and Geodetic Survey. Mr. Bates was author of several magazine articles on municipal improvements.

C. Glenn Cappel, Former Director of ASCE, Dies

C. Glenn Cappel (M. '24), age 66, vice-president of the W. Horace Williams Company, a division of Williams-McWilliams Industries, Inc., New Orleans, La., died in that city on December 12. During World War II Mr. Cappel was in direct charge for his company of the construction of numerous Army and Navy projects including the Naval Air Station at Houma. For the latter project he received the Navy's Meritorious Civilian Award. Other honors to him included a Certificate of Merit from New Orleans for his work in revising the city Building Code. Mr. Cappel was a pioneer in the design of offshore drilling platforms and wharfage facilities. He also gained wide renown for devising the method by which his firm moved the old Charity Hospital Building instead of demolishing it. He was a Director of ASCE from 1948 to 1950, and president of the Louisiana Section in 1946. Mr. Cappel was also a two-time recipient of the ASCE Construction Engineering Prize for articles in CIVIL ENGINEERING. A graduate of Louisiana State University, he was a special lecturer at the University of Mississippi.

C. Glenn Cappel

Morgan Cilley (M. '36), 77, retired Episcopal minister of Lewisburg, W. Va., died on June 29, 1955, though word of his death has just reached the Society. Reverend Cilley was an astronomer and civil engineer before he entered the ministry. While engaged in civil engineering, he served as an engineer on such projects as the building of the Pennsylvania Railroad tunnels under the Hudson River in New York, and on Government engineering work in the Philippine Islands. He was also supervising engineer for the Lehigh University campus improvements in 1907, and for many years was connected with the Public Roads Administration as U. S. assistant engineer. Reverend Cilley retired in 1940.

Wayne F. Davis (A.M. '49), age 53, assistant professor of civil engineering at the University of Oklahoma, died recently. Professor Davis had been teaching at the University since 1946, specializing in courses in plane surveying and route surveying, and in highway materials. Shortly after graduating from Oklahoma A. & M. in the early 1930's, Professor Davis served as inspector and, then, as construction superintendent for the Oklahoma State Highway Commission. More recently he was assistant city engineer for Oklahoma City, Okla. He was secretary-treasurer of the Oklahoma Section and faculty adviser of the Student Chapter of the university.

Abraham Epstein (M. '30), age 70, president of A. Epstein and Sons, Inc., of Chicago, Ill., died there on December 7. Mr. Epstein was the architect of the International Ampitheatre, the Borg-Warner Corporation office building and many other commercial structures in Chicago, including the reconstruction work after the fire in the Stock Yards in 1934. He worked as engineer and architect for the National Fireproofing Company, Marshall and Fox, and the Central Manufacturing District until 1921, when he entered private practice. Mr. Epstein graduated from the University of Illinois college of engineering in 1911.

W. J. Farrisee (M. '37), age 60, since 1955 dean of men and professor of engineering, Stevens Institute of Technology, Hoboken, N. J., died there on November 30. Mr. Farrisee previously was dean of men for Clarkson College of Technology at Potsdam, N. Y. He graduated in 1921 from Massachusetts Institute of Technology, and taught for a year at the University of Illinois before going to Clarkson, where he remained for thirty-one years.

Alfred P. Hughes, Jr. (J.M. '54), age 25, a recent civil engineering graduate of Lehigh University, died recently as a result of injuries sustained in an automobile accident. At the time of his death, Mr. Hughes was research engineer for Jet Propulsion Laboratories at Pasadena, Calif. His first job was as engineering draftsman with the American Bridge Division, of U. S. Steel at Ambridge, Pa.

Robert C. Hunter (M. '46), age 70, retired Colonel, died in Sacramento, Calif., November 13. Colonel Hunter was the Sacramento District engineer for the United States Army Corps of Engineers during the years of World War II, in which capacity he was responsible for large construction projects at installations in central California, Nevada and western Utah. Later, he was assigned to the Philippines and was in charge of engineering for the final big push in 1945 which led to the defeat of Japan. On his retirement from the army in 1947 he served as executive officer of the California State Lands Commission. Colonel Hunter recently completed writing a book of medieval history which members of his family plan to publish.

Charles Jensen (A.M. '46), age 63, civil engineer with Sullivan & Hoebel, of Chattanooga, Tenn., died there recently. Prior to joining Sullivan & Hoebel in 1957, he had been employed by the Tennessee Valley Authority for over twenty years, working in the highway and railroad division. In more recent years, he was responsible for the design of site grading, storm drainage, railroad yards, and related work for the Kingston Steam Plant. During the past year Mr. Jensen had worked on the planning and design of some of the new superhighways in the Chattanooga area. He was a graduate of the Georgia Institute of Technology.

Frank R. Lewis (M. '21), age 85, retired surveyor and civil engineer, of Kaufman, Tex., died there on December 3. Mr. Lewis worked with the U. S. Government surveying the Indian Territory of Oklahoma before it was admitted to statehood. After leaving government service, he entered private practice as a civil engineer, maintaining the practice until his retirement a few years ago. Mr. Lewis graduated from Texas A. & M. College in 1894.

Louis B. Litchfield (M. '51), age 58, assistant project engineer and associate of Metcalf and Eddy of Boston, Mass., died recently at Lamoine, Me. A graduate of the University of New Hampshire in 1923, he was with the Maine State Highway Commission for most of his career, retiring in 1951 as division engineer. Since then he had been with Metcalf and Eddy as design and project engineer in Green-

(Continued on page 108)

This great performance story began more than two years ago—and it's getting better all the time!

More than 50 Allis-Chalmers HD-21's are handling Toquepala's toughest jobs for Utah Construction Co. and Morrison-Knudsen Co., Inc.

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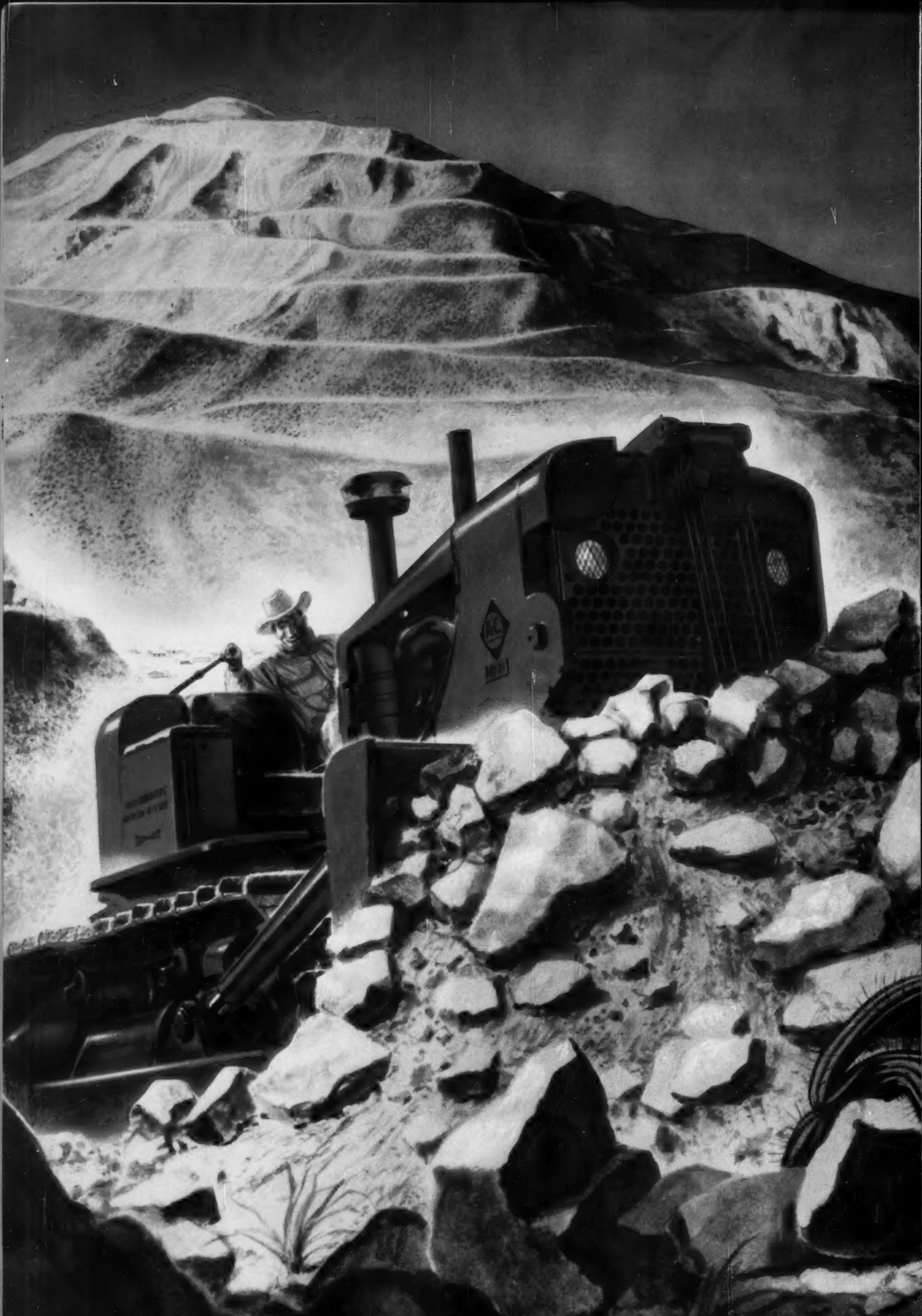


Working on New Frontiers high in the Peruvian Andes

Mining specialists . . . men of construction . . . and a great fleet of giant Allis-Chalmers crawler tractors are changing a remote, mountain-top desert into a modern mining center.

Toquepala (*pronounced Toe-kay-páh-la*) is its name—a wilderness hidden deep in the ancient land of the Inca Indians, so bleak and devoid of rain it's truly a mountain-top desert. There, 11,500 feet above sea level, one of the biggest mining projects in history is now under way.

Among the first machines moved ashore at the start of this venture were big Allis-Chalmers tractor-bulldozers, and today they're part of the team that is breaking through the barriers to Toquepala. To span the 100 miles from the mine to the nearest seaport, these giant tractors are pushing aside sand and rock to help build a network of roads and a railroad . . . and they're biting into mountainous terrain to level a site for a new town of 10,000 people.

Thus, the might of modern construction machinery is helping to unlock the treasures of Toquepala, considered inaccessible just a few years ago. And when the ore is ready for processing, 14 huge Allis-Chalmers mills will start grinding up this 400-million-ton mountain of copper ore at the rate of 30,000 tons a day . . . free the valuable mineral from the waste and prepare it for concentration, smelting and refining. Then, Toquepala will be one of the world's great copper mining centers, and long-range needs for this vital metal will be supplemented by a new source of supply.

From trail blazing to processing, this mammoth project typifies Allis-Chalmers service to the mining industry—through an unusually wide range of construction, power and processing equipment. It also typifies Engineering in Action . . . bringing better living to more people wherever it goes. ALLIS-CHALMERS, GENERAL OFFICES, MILWAUKEE 1, WIS.

Toquepala is a project of the Southern Peru Copper Corporation, which is stripping more than 120 million tons of overburden to reach the actual ore deposit at the mine. Major construction work for the roads, railroad and town site is being handled by two famous American contractors, Utah Construction Company and Morrison-Knudsen Company, Inc.

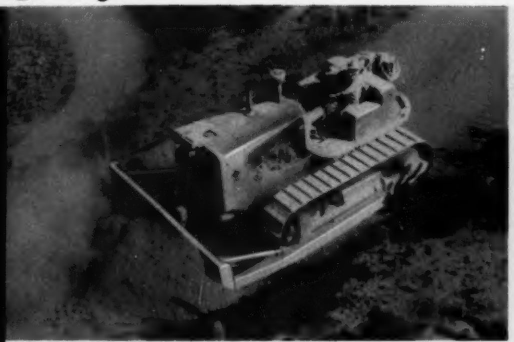
move ahead with

ALLIS-CHALMERS

. . . power for a growing world

At sea level . . . or 14,000 feet up

Allis-Chalmers HD-21's are the tractors for your tough jobs



Men and machinery conquer the mountain-top desert . . . push aside rock and sand to build access roads.

Big Allis-Chalmers tractor-dozers cut the rocky, mountain country to size to develop a town site.

HD-21 — 225 net engine hp; torque converter drive; 56,260 lb (approx. as shown)

You, too, can have the outstanding performance Utah Construction Company and Morrison-Knudsen Company, Inc. are getting from the more than 50 Allis-Chalmers HD-21's at Toquepala. Call your Allis-Chalmers dealer now. He will demonstrate the HD-21 on your job at your convenience.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

move ahead with

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...power for a growing world

Form MS 1316

Litho U.S.A.

Asphalt plays two roles on this Pennsylvania highway

Constructing a heavy-duty hot-mix Texaco Asphaltic Concrete pavement on 10 miles of State Route 22, near Harrisburg, Pa. General Contractor — N. Garman and Sons, Reading, Pa. Paving Contractor — Windsor Service, Inc., Reading.

The Pennsylvania Highway Department completed one of its largest Asphalt projects to date on a 10-mile section of State Route 22 near Harrisburg.

Texaco Asphalt, which was used exclusively by the contractors in this work, performed a double function. It was used both to underseal and to resurface the old rigid pavement originally constructed on the highway.

Approximately 2,000 tons of a relatively hard Texaco Asphalt was pumped through holes drilled into the old pavement, filling all cavities formed by subgrade settlement.

This was followed by a heavy-duty hot-mix Texaco Asphaltic Concrete surface, constructed in two courses on top of the existing slab. Approximately 60,000 tons of Asphalt mix were required.

From Pennsylvania to the Rockies, road builders have been paving with Texaco Asphalt for well over half a century. Whether traffic calls for a heavy-duty pavement or an inexpensive surface-treatment, there is a type of Texaco Asphalt construction to fit the need. Helpful information on all of these types is supplied in two brochures. Write for copies.

THE TEXAS COMPANY, Asphalt Sales Div., 135 E. 42nd Street, New York City 17

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TEXACO ASPHALT

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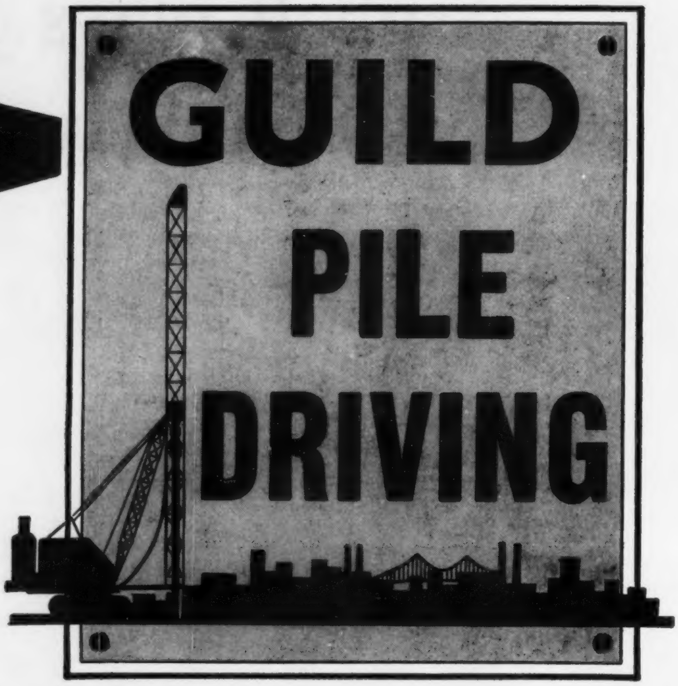

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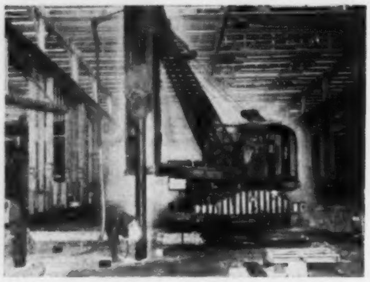

Inside a building . . . out in a desert . . . along the shore line

no matter where the job—anywhere in the United States, no matter what the time of year, the climate, or the soil condition, fast-acting G. L. GUILD has a record for successfully completing piling jobs. Specialists in the use of COBI Cast-in-Place Piles, experts in driving every type of pile on any type of job. Ask for factual data.

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large in scale

depend upon the unequalled experience of

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Pittsburgh, Pa. 2,500,000 Gallons

Elevated steel tanks of largest size are supplied by PDM to meet the increasing water storage volumes required by America's ever-expanding communities. ● Engineering of highest excellence, precision fabrication and sure craftsmanship in erection have distinguished Elevated Steel Tanks by Pittsburgh-Des Moines since 1897. Write for prompt quotations.

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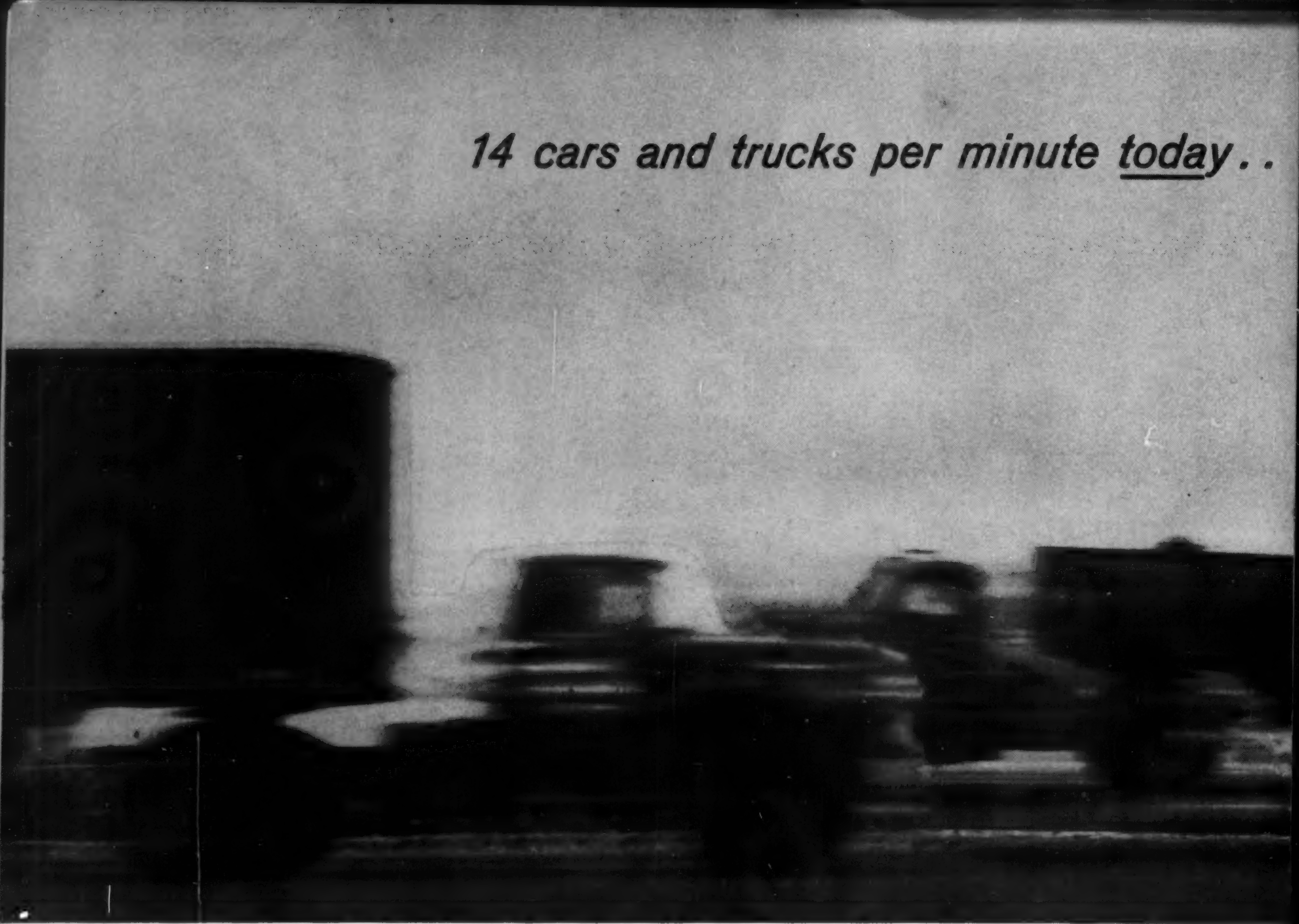


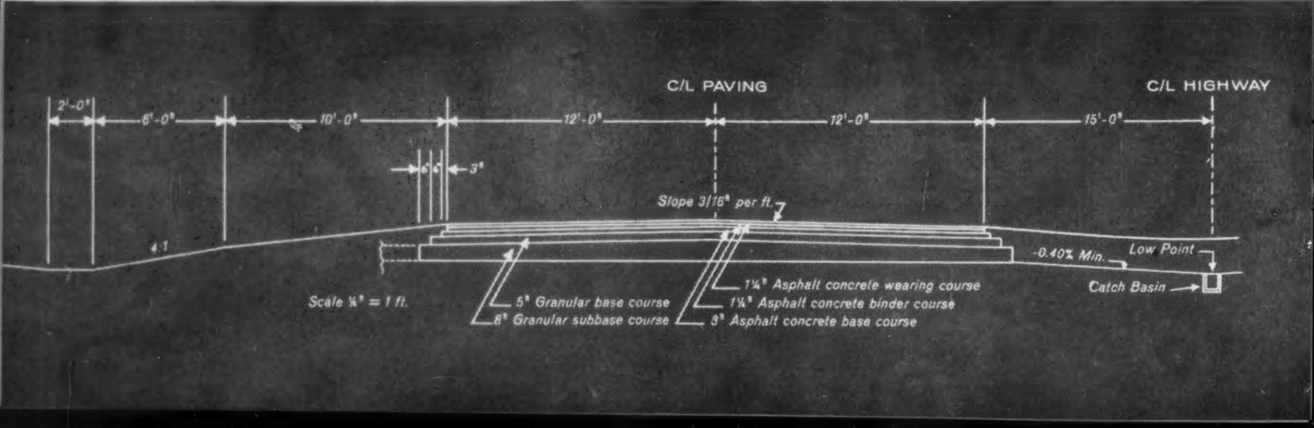
Here's one reason why Ohio's

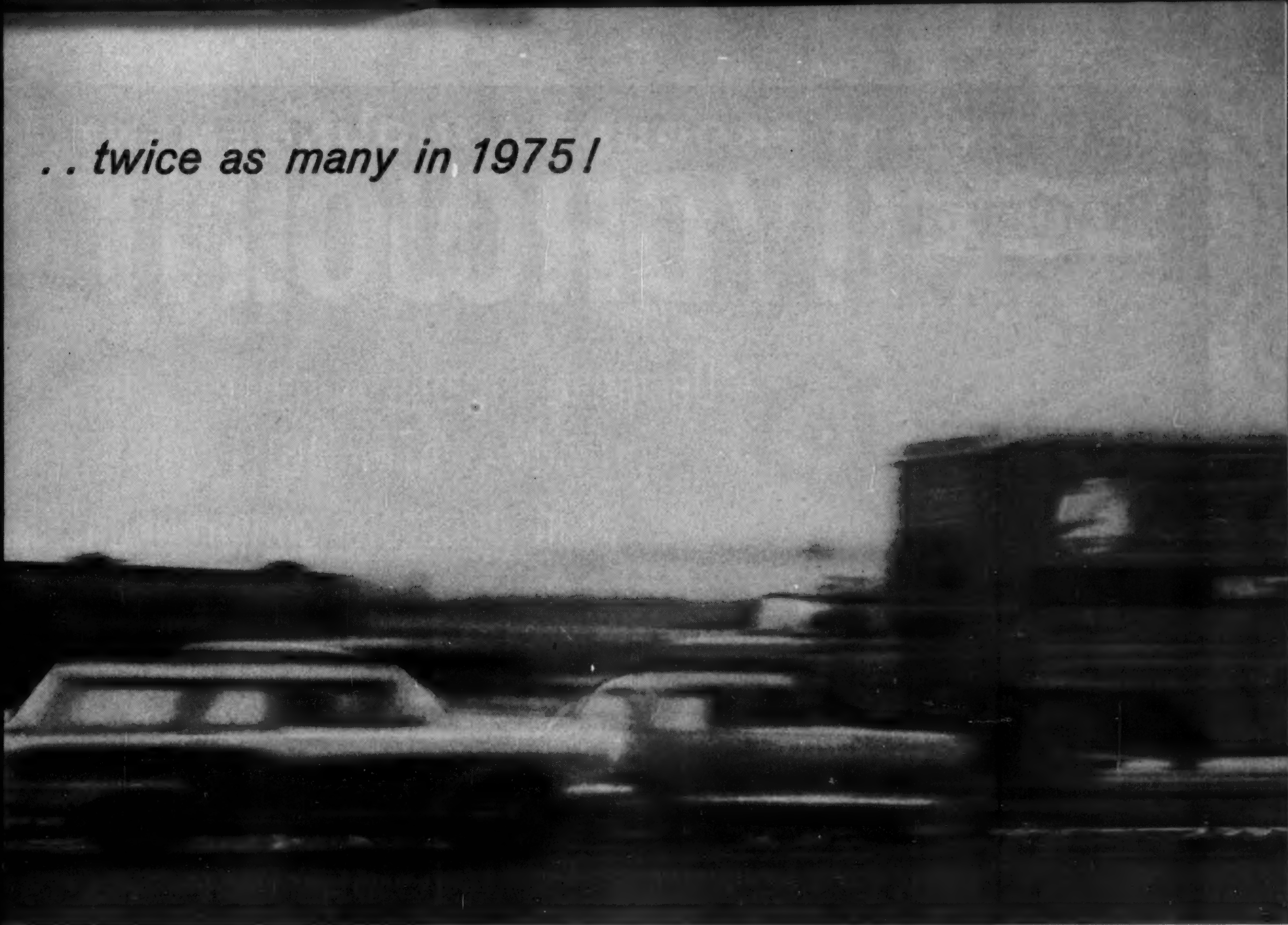
Pounding traffic! Growing traffic volume! Greater and greater axle loads!

These assaults on pavement structures are **not** restricted to the 90-10 Interstate highways. They're common problems faced by engineers responsible for thousands on thousands of miles of road like Ohio's new State Route 73 . . . roads which are to be built largely out of State funds and wholly maintained with these monies.

In most terrain these roads . . . like your Interstate roads . . . should be Asphalt-paved. For many reasons! Perhaps the **most** important is that modern Asphalt

Typical of modern heavy-duty Asphalt sections is this one for Ohio's 5-mile State Route 73 between Middletown and Franklin. Median section is modified to a raised and curbed 15-foot section in urban areas. Pavement must support a heavy traffic of trucks carrying steel, machine tools and other industrial products produced locally. Cost per sq yd for this Asphalt road $3.03; $2.00 per sq yd under the prevailing price for reinforced concrete.





new Route 73 is Asphalt-paved

pavement structures are being built today to handle **any** desired loads with **any** desired built-in durability . . . **and these roads save money.** Cost less to build, less to maintain.

Your State can lay more road for the same money if you design for Asphalt concrete. More road means the traffic load on **all** pavements in your State can be kept at a maintenance-saving minimum.

THE ASPHALT INSTITUTE
Asphalt Institute Building, College Park, Maryland

Glacial till in right-of-way favored Asphalt pavement construction. Whenever sub-soil of this type is found it provides excellent natural subgrades for Asphalt paving. Proximity of suitable crusher-run aggregate also favored use of Asphalt on Route 73.

Comfortable! Durable!... because it's modern Asphalt concrete. Notice the smooth-riding, skid-resisting surface. Notice the visibility, too, of the traffic markings on Route 73. With Asphalt concrete, this road sets a standard for quality construction.

Here's <u>one</u> reason why Ohio's

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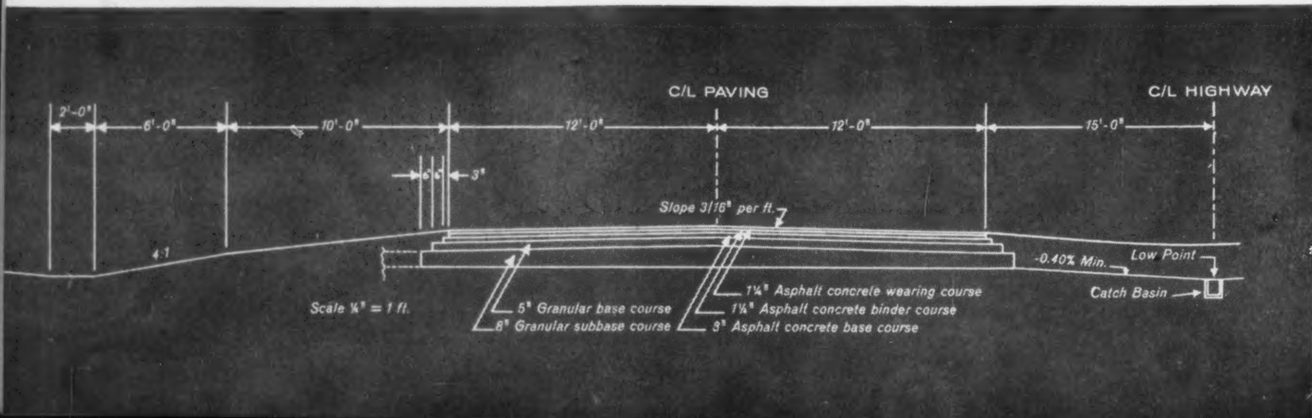

IMPORTANT PRODUCT ANNOUNCEMENT

SEALTIGHT® HYDROJOINT

TRADEMARK

Designed for one purpose . . . to provide WATERTIGHT joints in concrete construction!

new Route 73 is Asphalt-paved

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PVC POLYVINYLCHLORIDE WATERSTOPS

W. R. Meadows, one of the nation's first manufacturers to promote and sell a PVC Waterstop, now introduces a new, modern, improved Waterstop that obsoletes others on the market. The outstanding value of PVC is a proven fact ... however, there are many grades of PVC available. "HYDROJOINT" PVC Waterstops are extruded from a special compound of Polyvinylchloride to which has been added important plasticizers and stabilizers to provide all of the qualifications necessary for the effective performance of a Waterstop. "HYDROJOINT'S" multi-ribbed cross-section provides a permanent and tenacious grip to the concrete in which it is embedded . . . the hollow center bulb provides the flexibility and elasticity necessary to safely and efficiently handle extension and transverse movements. "HYDROJOINT'S" special PVC compound and cross-section design qualify it as the "QUALITY" leader in its field . . . a quality product priced competitively and designed to do one job well—stop water leakage through joints of concrete structures.

IMPORTANT FEATURES . . .

- The "QUALITY" leader . . . extruded from a special PVC compound for long-life performance . . . engineered with a unique cross-section featuring improved-design multi-ribs to provide a tenacious holding power and re-engineered center bulb to provide the ability to successfully handle tremendous pressures caused by concrete movements.
- "HYDROJOINT" PVC Waterstops are strong, lightweight, and easy to handle . . . supplied in 50 ft. coils . . . individually packaged. They are flexible and may be bent around corners or formed in curves to meet your requirements. Easy to install . . . any necessary formwork is easy to construct and may be re-used time and time again.
- SPECIFICATIONS:
  Tensile Strength................2250 psi, ASTM D412-51T
  Ultimate Elongation..............................300%
  Temperature Range...............from +176°F to —50°F
  Cold Brittleness Test.............—50°F, ASTM D746-55T
  Chemically resistant to chlorinated water, salt water, acids, alkalis, sewage wastes, oil, etc.

HYDROJOINT PVC WATERSTOPS FOR POSITIVE

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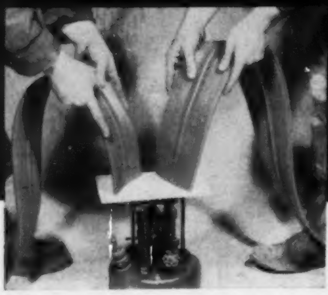

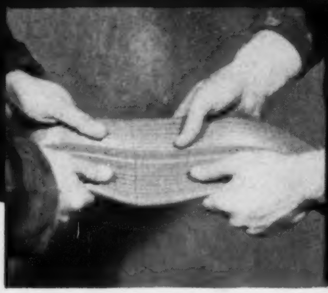

QUICK AND EASY TO SPLICE ON-THE-JOB!

"HYDROJOINT" PVC Waterstops make on-the-job splicing as easy as a-b-c . . . does not require special vulcanizing equipment or skilled labor. Using a plumber's torch for your heat source, you merely heat a steel plate to approximately 450° . . . hold the ends of the Waterstops to the plate until melting occurs . . . then press the ends together until the splice cools. It's the fast, easy and economical way to make splices of all types including tee-joints, box-joints, cross-joints and butt-splices.

HYDROJOINT PVC WATERSTOPS PROVIDE AN IMPORTANT ADDITION TO THIS "SEALTIGHT" PRODUCT LINE..

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- "HYDROMAT" asphalt liners for irrigation projects, reservoirs, waste control ponds, municipal water and sewage projects and military installations.
- Expansion Joints of all types including asphalt, fibre, cork and sponge rubber.
- Joint Sealing Compounds—Rubber Asphalt —Hot and Cold Pour—Regular and JFR.
- Roof Coatings and Cement.
- Plaster Bond.
- Silicone Waterproofing.
- Concrete curing compounds—Air Entraining agents.

Write TODAY for complete information on any of the above products

POLYVINYLCHLORIDE PVC WATERSTOPS

W. R. Meadows, one of the nation's first manufacturers to promote and sell a PVC Waterstop, now introduces a new, modern, improved Waterstop that obsoletes others on the market. The outstanding value of PVC is a proven fact ... however, there are many grades of PVC available. "HYDROJOINT" PVC Waterstops are extruded from a special compound of Polyvinylchloride to which has been added important plasticizers and stabilizers to provide all of the qualifications necessary for the effective performance of a Waterstop. "HYDROJOINT'S" multi-ribbed cross-section provides a permanent and tenacious grip to the concrete in which it is embedded ... the hollow center bulb provides the flexibility and elasticity necessary to safely and efficiently handle extension and transverse movements. "HYDROJOINT'S" special PVC compound and cross-section design qualify it as the "QUALITY" leader in its field ... a quality product priced competitively and designed to do one job well—stop water leakage through joints of concrete structures.

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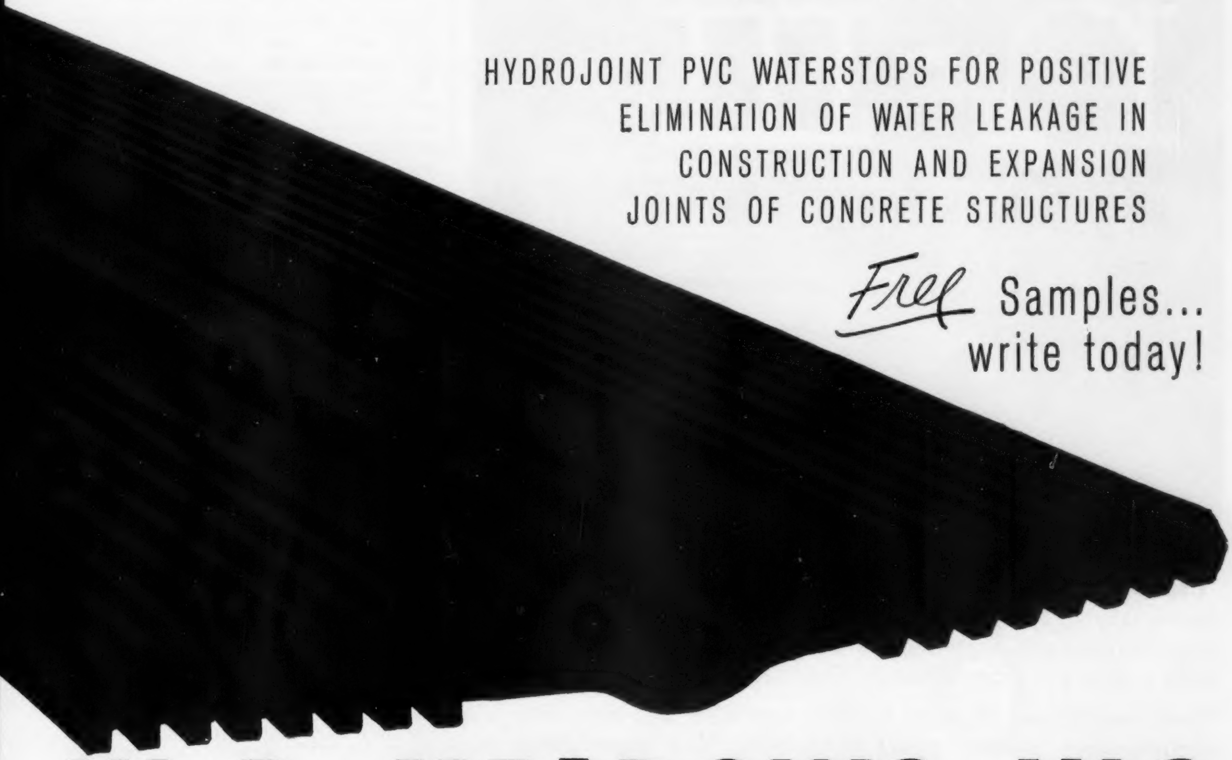
  Cold Brittleness Test.............—50°F, ASTM D746-55T
  Chemically resistant to chlorinated water, salt water, acids, alkalis, sewage wastes, oil, etc.

HYDROJOINT PVC WATERSTOPS FOR POSITIVE ELIMINATION OF WATER LEAKAGE IN CONSTRUCTION AND EXPANSION JOINTS OF CONCRETE STRUCTURES

Free Samples... write today!



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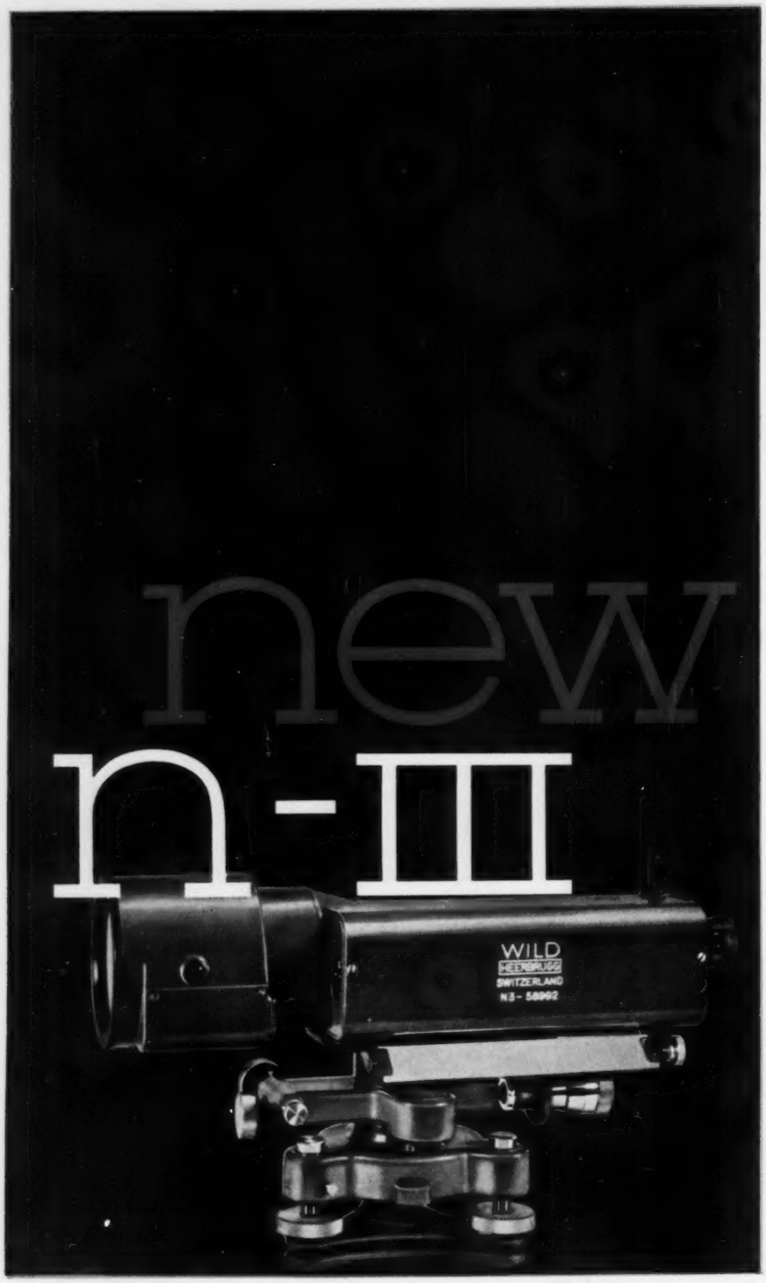

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Three models are available to meet both field and industrial requirements, reading direct to .1 mm; .001 inch; .0005 ft.

All have tilting screw, coincidence level and built-in optical micrometer.

Write for Booklet N-III.

HEERBRUGG

Deceased

(Continued from page 96)

land, Spain, Labrador and Alaska. During World War II he served in the Civil Engineer Corps of the U. S. Naval Reserve, attached to various units of the Seabees in this country and in England, Scotland and Alaska.

Alfred M. Lund (M. '17), age 78, retired civil engineer, of Little Rock, Ark., died there on October 31. A graduate of Vanderbilt University, he had been a civil engineer in Little Rock for many years prior to his retirement three years ago. He was well known as a civic leader and for his engineering services on many local projects. Mr. Lund served in the Corps of Engineers as a major in World War I.

Reginald A. McFarland (M. '54), age 58, head of the department of civil engineering at Louisiana Polytechnic Institute, Ruston, La., died there on September 9. Professor McFarland, fondly known as "Mr. Mac," was one of the pioneers in engineering education at Louisiana Polytechnic Institute. He joined the teaching staff in 1926, and in 1928 was named head of the Department of Civil Engineering, a post he filled for thirty years.

Earle F. Miles (A.M. '45), age 53, engineer and land surveyor at Cuero, Tex., died on October 20. Early in his career Mr. Miles specialized in the design and supervision of construction of water and sewer plants and systems for several cities of Texas. He had also done engineering work on a four-year Federal Aid Improvement Program amounting to $1,200,000. More recently, Mr. Miles had been engaged as a surveyor for the Skelly Oil Company, of Tulsa, Okla. He was a graduate of Texas A. & M. College.

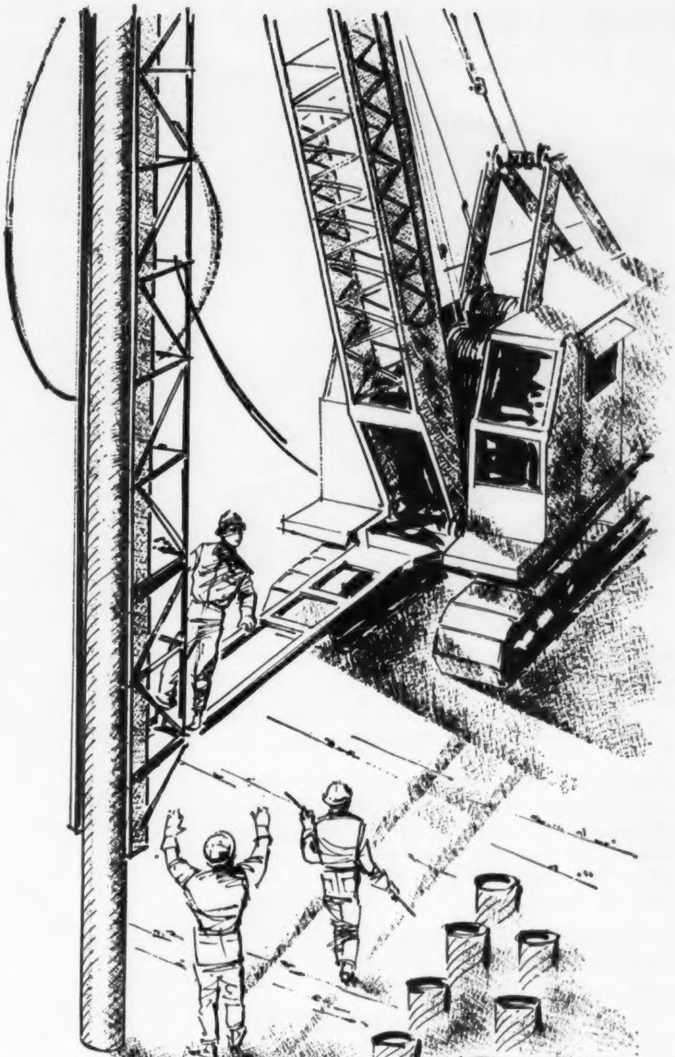
Harold W. Mutch (M. '47), age 63, retired construction engineer for the U. S. Bureau of Reclamation, and resident of Long Beach, Calif., died there recently. Mr. Mutch served the Bureau for over thirty-five years as supervisor, planner, and construction engineer on various irrigation and reclamation projects. One of his first jobs for the Bureau was as assistant engineer on the Salt Lake Basin Project in Utah. Later he was associate engineer on the Ogden River Project in Utah and, more recently, acting project engineer on the Missouri Basin Project in Montana.

Asa G. Proctor (M. '35), consulting engineer of Woodland, Calif., died recently. He had served as county surveyor of Yolo County and city engineer of Woodland for over forty years. Mr. Proctor was a past president of the Sacramento Section, and president since 1953 of the California State Board of Registration for Civil and Professional Engineers. Appointed to the Registration Board by Governor James Rolph in January 1932, he was reappointed by five succeeding governors

(Continued on page 110)

For foundations of many of your bridges or buildings, Armco HEL-COR® Pile Shells offer you important advantages.

With Armco HEL-COR Pile Shells
You Can Drive a Strong Foundation Fast



Their light weight speeds handling. They are extremely straight, and uniform in diameter. Thus, HEL-COR Pile Shells are quickly mandrel-driven to the required loading. With the wide, flat, capped ends of Armco Pile Shells, you get maximum support.

Because Armco Pile Shells are supplied in lengths up to 64 feet, and random cut-off lengths may be field-welded together for other piles—you can make substantial savings during installation.

This is HEL-COR

Armco HEL-COR Pile Shell is a continuous lock-seam corrugated metal pipe made on automatic machines.

It is formed with helical corrugations, and the pipe is joined with a single permanent lock seam that follows the spiral in the valley of the corrugations. Lock seam can be welded if desired.

This pile shell can be mandrel-driven, used as drop-in pile shell, or as the top part of composite piles. Nominal diameters range from 10⅝ to 22 inches, and gages from 14 to 18.

For complete data on Armco Pile Shells, send coupon. Armco Drainage & Metal Products, Inc., 4539 Curtis Street, Middletown, Ohio. In Canada: write Guelph, Ontario.

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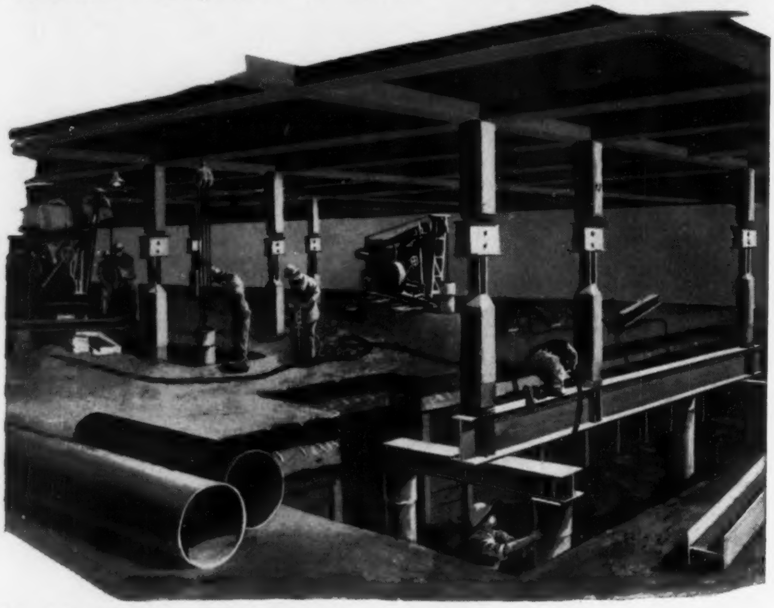
ANOTHER PROBLEM SOLVED BY SPENCER, WHITE & PRENTIS

UNDERPINNING OF PIER POSES MANY CONSTRUCTION PROBLEMS

Timber and rip-rap obstructions—vibration problem—limited headroom—complicate installation of 14-inch Drilled-In Caissons



Project: **Underpinning Pier 3, Hudson River, for United Fruit Co.**
Owner: **Department of Marine & Aviation, City of New York**
Engineers: **Dept. of Marine & Aviation, Captain L. H. Rabbage, Chief Engineer**
United Fruit Co., H. C. Ames, Division Engineer
Consultant: **Moran, Proctor, Mueser & Rutledge**

Underpinning was required for Pier 3 on New York City's Hudson River. Sketched above is a portion of the new support system, which consists of 14-inch steel pipe piles socketed into bedrock.

To install this underpinning with minimum vibration and to carry the piles through rip-rap, timber cribs and hardpan, specialized drilling procedures were used, the design of the drill rigs being modified to operate in the very limited headroom available.

When you encounter foundation problems, Spencer, White & Prentis is long-practiced in prescribing sound solutions.

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PITTSBURGH: EMPIRE BLDG. • OF CANADA: 2052 ST. CATHERINE ST. WEST, MONTREAL

Deceased

(Continued from page 108)

and served twenty-seven years. Eight days before his death the Engineering Council of Sacramento Valley awarded him a citation for "many years of technical and professional leadership among engineers of the community and the state."

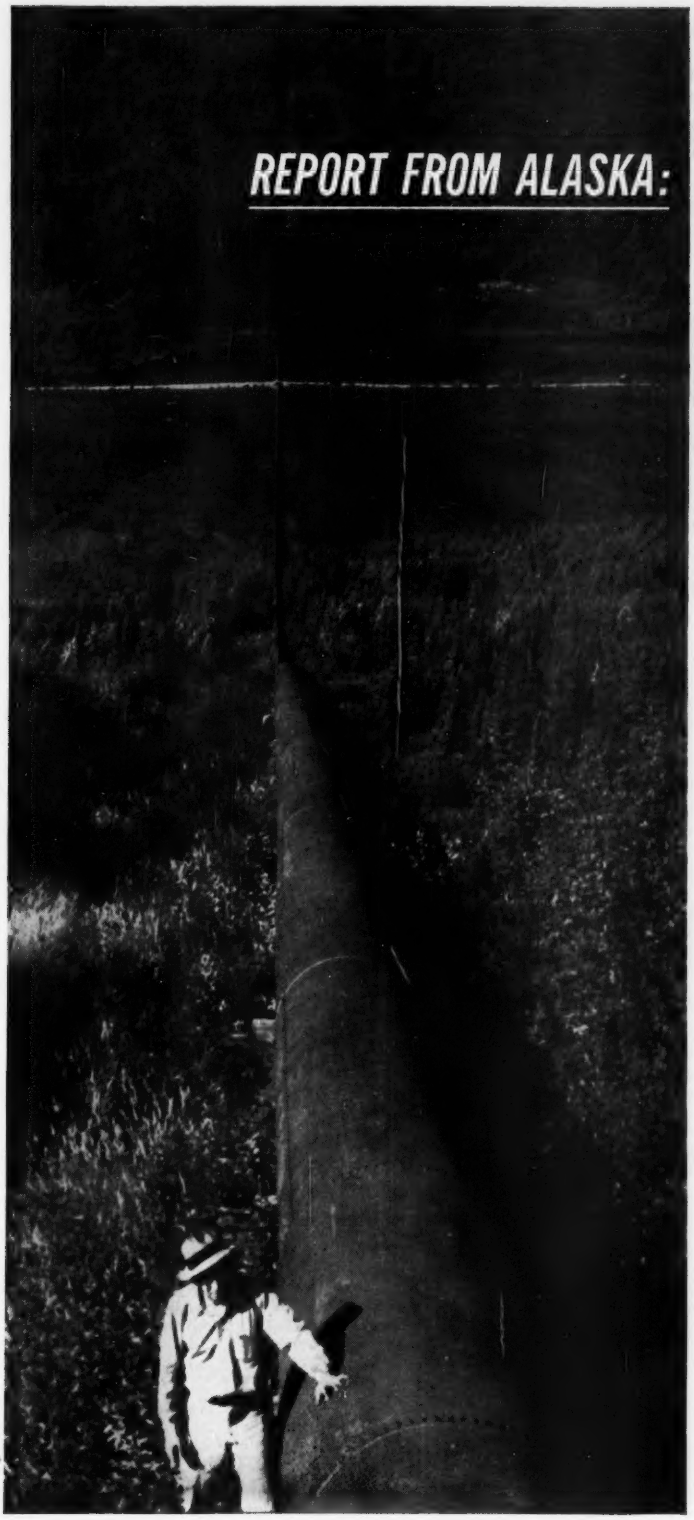
John P. Redwood (M. '30), age 62, consultant for public utilities in New York City, died there on September 23. A graduate of Cornell University, Mr. Redwood specialized in water supply systems, sewerage works, and water power projects. Prior to entering private practice in 1951, he had served for over fifteen years with the New York State Public Service Commission as inspector, assistant, hydraulic engineer, and associate rate case analyst. Mr. Redwood had also been engineer for the Erie County Water Authority and consulting engineer for the City of Fort Lauderdale, Fla.

Theodore Schwartz (A.M. '54), age 39, owner, Ted Schwartz, engineering contractor, of Grass Valley, Calif., died recently. He was a graduate of the University of California with a B. S. in civil engineering. Mr. Schwartz had been a resident of Grass Valley since 1946, when he became resident engineer there for the Nevada Irrigation District in charge of the reconstruction of French Lake Dam. In 1947 he went into private practice.

William J. Steinmetz (A.M. '24), age 65, structural engineer for the Corps of Engineers, at Los Angeles, Calif., died recently. He was a graduate of the University of Colorado with a B. S. in civil engineering. As designer and principal office assistant for the Long Beach Harbor Department for many years, Mr. Steinmetz designed a $1,250,000 bulkhead for the harbor.

Robert Patton White (M. '47), age 61, supervisory general engineer for the Eastern Design and Construction Office of the National Park Service, with headquarters at Philadelphia, Pa., died there on November 30. A graduate of West Virginia University with a B. S. in civil engineering, he started his career with the National Park Service in 1931. Prior to becoming supervisory general engineer in 1954, he was park engineer and assistant park superintendent for the Great Smoky Mountains National Park.

Jackson H. Wilkinson (M. '42), age 66, who retired in 1957 from the Tennessee Valley Authority, died suddenly in Knoxville, Tenn., on November 29. Mr. Wilkinson received his B. S. and M. S. in civil engineering from the University of Illinois. He was a veteran of World War I, having served as an officer in Panama and in this country. Except for a few years of bridge design and construction in his home state of Illinois, his life work was in the fields of hydraulics and hydrology. During the last twenty years of his professional activities, he developed the procedure and was in charge of river forecasting for operations of the TVA multipurpose system.



Steel pipe maintains flow capacity through 30 years of rugged service

Temperatures down to 66° below, hydrostatic heads up to 544 ft

One of the world's northernmost large-diameter pipe lines is located near Fairbanks, Alaska, where United States Smelting Refining and Mining Company has been mining gold since 1928. The company's hydraulic stripping operation calls for a tremendous volume of water, most of it flowing 90 miles from the Chatanika River.

While the supply line consists chiefly of open ditch, over 6 miles of steel pipe carry water across fifteen streams and valleys. The longest crossing totals 7962 ft. The pipe is of lock-bar construction, in 30 ft lengths, 46 and 56 in. ID. Walls vary from ¼ in. to 7/16 in.

The line has been in service throughout the operating seasons (150 days average) since 1928, except for a wartime shutdown. Despite the unusually high heads, up to 544 ft, and temperatures as low as 66 deg below zero, the pipe has given excellent service. Company officials report that leakage has been minor, and there has been no measurable loss of flow capacity.

Reports like this, from all 49 states, are persuasive evidence of the fine performance of large-diameter steel pipe—even under the most rigorous service conditions. Plan on Bethlehem Steel Pipe for your next water supply project.

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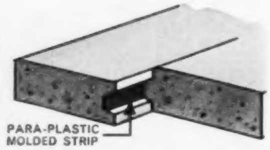
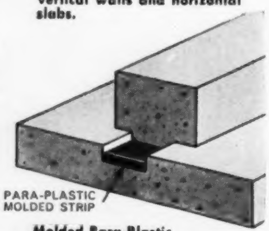
Molded Para-Plastic is a durable, elastic compound, composed of rubber, asphalt and other materials, molded into a rectangular strip. Properly installed, Molded Para-Plastic will bond securely to concrete to form a resilient and moisture-tight seal of the joint.

Because it presents sealing surfaces on all sides, Molded Para-Plastic is especially effective in sealing keyed construction joints and foundation footings. Not recommended for use in joints where the surface of the material is exposed, or when hydrostatic pressure is present. Available in various sizes with thickness ranging from ¼" to 1" and widths from 1 to 12 inches. Standard length is 5 feet.



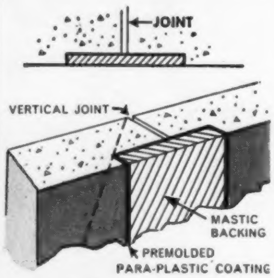
Keyed construction joint in vertical walls and horizontal slabs.



Molded Para-Plastic sealing at a footing.

PARA-LATERAL STRIP

Consists of a rigid mastic backing material coated on one side and two edges with a Para-Plastic rubber-bituminous sealing compound which bonds firmly to the concrete after it has set up, to form a watertight seal. Designed for use in vertical and sloping joints in concrete retaining walls, abutments, wing walls, foundation walls, tunnels, etc., where backfilling against one side of the structure requires a seal to prevent seepage of ground water through the joint to the exposed side. Available in widths of 4", 5", 8", 12", and 13"; standard length is 5 feet.



Application of Para-Lateral Sealing Strip to rear face of wall at joint.

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Non—ASCE Meetings

Alabama Highway Conference. Second annual meeting at the Alabama Polytechnic Institute in Auburn, March 16-17. Contact A. S. Chase, General Chairman, Second Annual Conference, Alabama Polytechnic Institute, Auburn, Ala.

American Concrete Institute. Annual meeting at the Statler Hilton Hotel, Los Angeles, Calif., February 23-26. Information available from Charles L. Cousins, ACI, P. O. Box 4754, Redford Station, Detroit 19, Mich.

American Society for Metals. Eleventh Western Metal Exposition and Congress at the Pan-Pacific Auditorium and Ambassador Hotel, in Los Angeles, Calif., March 16-20. For reservations write Ray T. Bayless, Assistant Secretary, 7301 Euclid Avenue, Cleveland 3, Ohio.

American Society of Photogrammetry—American Congress on Survey & Mapping. 1959 ASP-ACSM Consecutive Meetings at the Shoreham Hotel in Washington, D. C., March 8-14. Reservations may be made through the Shoreham Hotel, 2500 Calvert Street, N. W., Washington 8, D. C. For additional information on the meetings contact: John H. Wickham, Jr., Director 1959 ASP-ACSM Consecutive Meetings, 610 Montgomery Street, Alexandria, Va.

Engineers Joint Council. 1959 Nuclear Congress at the Public Auditorium in Cleveland, Ohio, April 5-10. EJC is the coordinating agency for the Congress. For additional information write EJC, 29 West 39th Street, New York 18, N. Y.

Georgia Institute of Technology. Eighth annual Georgia Highway Conference at the Institute, March 9-10. Address inquiries to Richard Wiegand, Director, Short Courses & Conferences, Engineering Extension Division, Georgia Institute of Technology, Atlanta, Ga.

Louisiana State University. Twenty-second Annual Short Course for Superintendents and Operators of Water and Sewerage Systems at the University, March 18-20. For additional information write to the University at Baton Rouge, La.

National Society of Professional Engineers. Winter professional meeting at the Dinkler-Tutwiler Hotel, Birmingham, Ala., February 18-21. For further information write Kenneth E. Trombley, NSPE, 2029 K Street, N.W., Washington 6, D. C., or call Federal 7-2211.

University of Colorado. Thirty-second Annual Colorado Highway Engineering Conference sponsored by the Department of Civil Engineering, University of Colorado, Boulder, Colo., March 5-6. Write Roderick L. Downing, Chairman, Department of Civil Engineering, University of Colorado, Boulder, Colo.

University of Illinois. Forty-fifth Annual Illinois Highway Engineering Con-

(Continued on page 118)

Announcing the Second Annual

ALFRED A. RAYMOND AWARD

1959

An award of $1,000 will be given annually in honor of Alfred A. Raymond, inventor of the cast-in-place concrete pile and founder of the Raymond Concrete Pile Company. It will be presented to the author of the best paper on "Design and Construction of Foundations of Structures," as selected by a committee of eminent judges. Authors should be either engineering undergraduates, graduate students, faculty, designing and practicing engineers, or those engaged in the field of foundation engineering.

The topic "Design and Construction of Foundations for Structures" is to be interpreted broadly. It covers all phases of foundation engineering from the initial planning to the final installation of a foundation for a structure. Engineers are cordially invited to submit a paper on whatever aspect of foundation engineering or construction of foundations will contribute to knowledge in the field. Manuscripts may deal with foundation test borings, soil mechanics, the theory of foundation design, actual foundation construction, either temporary or permanent, and other related subjects. Papers must be submitted by September 1, 1959.

If you wish to compete for this award, simply write for a complete set of detailed regulations: Dept. C, Alfred A. Raymond Award, Room 1214, 140 Cedar Street, New York 6.

Positions Announced

U. S. Navy. Vacancy for General Engineer (GS-9) on Guam. Position calls for investigating and testing soils and aggregates. Must have civil engineering degree, plus one and a half years of experience. Apply to Navy Overseas Employment Office (Pacific), Section C-4, 45 Hyde Street, San Francisco 2, Calif.

City of San Diego. Principal Assistant to the City Engineer wanted for growing engineering department. Salary to $1,105 month. Applicants must have the equivalent of a degree in civil engineering, plus 10 years' civil experience, including 5 years at supervisory level, California registration, and be not more than fifty-two years old. Contact San Diego Civil Service, Room 453, Civic Center, San Diego 1, Calif.

Department of the Navy. Vacancy for Materials Engineer (GS-806-12) with the District Public Works Office, Thirteenth Naval District, Seattle, Wash. Salary—$8,810-9,530. Must have civil engineering degree or equivalent experience, plus three and a half years of experience. For information and applications write Industrial Relations District Public Works Office, Thirteenth Naval District, Building 250, U. S. Naval Station, Seattle 99, Wash.

RECENT BOOKS

(added to the Engineering Societies Library)

A History of Technology

Volume V. The Late Nineteenth Century, c.1850-c.1900

The importance of applied science and its effect on manufacture and production in the latter half of the nineteenth century is the outstanding theme of the present volume which concludes the series. Also considered is the social effect of scientific industry upon the lives of individuals. Topics presented include primary production, prime movers, the chemical industry, transport, civil engineering, and manufacture. (Edited by Charles Singer and others. Oxford University Press, 417 Fifth Avenue, New York 16, N. Y., 1958. 888 pp., bound. $26.90.)

Construction Accounting and Financial Management

Proper accounting and management procedures are related to the basic operational patterns of the construction firm. Topics discussed are pre-job procedures, purchasing policies, change orders, vouchering, control of receipts and disbursements, classification of accounts, financial statements and reports, auditing, insurance, and business machines as well as other aspects. Practical reasons are given to indicate why procedures that are standard in other businesses are either not used or are sharply modified. (By William E. Coombs. F. W. Dodge Corp., 119 West 40th Street, New York 18, N. Y., 1958. 490 pp., bound. $12.85.)

Construction Management and Superintendence.

Examines the complex division of duties, responsibilities, and procedures among the owner, the architect, and the contractor. In part one the author covers the details of construction management. Using specific examples he deals with contracts and subcontracts, changes of contracts, purchasing and deliveries, cost records, job office control, and the records necessary to keep track of hiring and discharging workers. Part two describes how to supervise each of thirteen trades to see that plans and specifications are followed from start to finish. Included are sub-grade work, concrete work, masonry, roofing, lathing and plastering, floor finishing, and painting. (By Walter C. Voss. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N. J., 1958. 238 pp., bound. $6.95.)

Fundamentals of Digital Computers

Following a discussion of fundamentals the author explains computer arithmetic applications, binary counting, and special codes; computer circuitry, including the various gates and the circuity utilizing them; various storage systems found in modern computers; computer programming, including specific examples of programming applied to commercial units; comprehensive descriptions of representative commercial computers. A concluding section deals with servicing and maintenance factors. (By Matthew Mandl. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1958. 297 pp., bound. $9.00.)

Grenzschichtforschung

A compilation of the lectures and discussions of a conference sponsored by the International Union of Theoretical and applied Mechanics in August, 1957. Various types of boundary layers—turbulent, laminar, rotating laminar, and thermal—are discussed. There are also papers on the mechanism of boundary layer transition at subsonic and at supersonic speeds, as well as on mathematical theory of shear-flow turbulence and the solution of boundary layer equations. Many of the papers are in English. (By H. Görtler. Springer-Verlag, Berlin, Germany, 1958. 411 pp., bound. 67.50 DM.)

Highway Research Board Proceedings, 1958

A survey of the work currently being done in the field of highway research. Areas discussed are economics, finance, and administration; design, including an extended discussion on the experimental prestressed highway project in Pittsburgh; materials and construction; maintenance; traffic and operations, including a study of electronic control of motor vehicles on the highway; soils, geology and foundations. (Published by National Research Council, Highway Research Board, Washington 25, D. C., 1958. 676 pp., bound. No price given.)

Hydrology for Engineers

Emphasizes practical, well-tested methods for the application of hydrology in engineering. Techniques are stressed which utilize correlation methods and eliminate judgment to the maximum possible extent. Topics covered are weather, precipitation, streamflow, evaporation and transpiration, groundwater, runoff, streamflow routing, frequency and duration studies, sedimentation, and application of hydrologic techniques. (By Ray K. Linsley, Jr., and others. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1958. 340 pp. bound. $8.00.)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translations services, and can supply photoprint or microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

(Continued on page 124)

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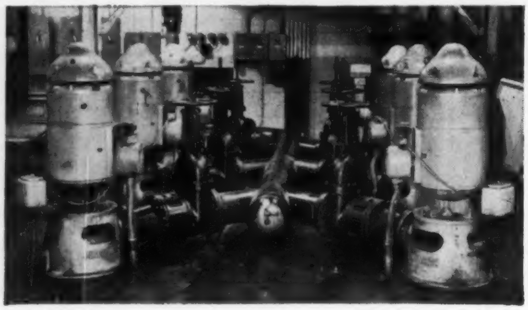

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Steel construction permits easy and thorough inspection

THE OLD Harrison Street Bridge over Carnegie Lake in Princeton Township, N. J., was being inspected when this picture was taken in the spring of 1958. And, as expected, the steel structure, which was built by American Bridge 52 years ago, was again found to be in practically perfect condition.

But, that's not the point . . . for it is a firmly established fact that no modern construction material is stronger, more wear-resistant, and longer-lasting than structural steel.

The significant point is that structural steelwork lends itself to *easier and much more thorough inspection* than any other type of construction material.

As you can see, inspection of this old bridge was conveniently made from a boat, which not only enabled the engineer to thoroughly scrutinize the underside of the superstructure, but also provided easy access to the piers.

The condition of steel is obvious during manufacture, during fabrication, during erection and years after installation. With steel, there is never any need for guesswork. *A steel structure is always easy to check visually.*

So, to the other advantages which so clearly make steel the soundest construction material, add "ease of inspection." For, down through the years this important advantage will contribute increasingly to the safety of the structure by enabling you to detect and correct *quickly* any possible wear or tear.

AT YOUR SERVICE—American Bridge has the experience and facilities to handle any type of construction. For further information, get in touch with any of the offices listed below. *USS is a registered trademark*

$44,000 STEEL HIGHWAY BRIDGE DESIGN COMPETITION—Deadline—May 31, 1959. Open to Professional and Design Engineers and College Engineering Students. No geographic restrictions. Send for Free Entry Booklet which fully explains how to prepare your entry. Write to Competition Editor, Room 1831, American Bridge Division, 525 William Penn Place, Pittsburgh 30, Pa.

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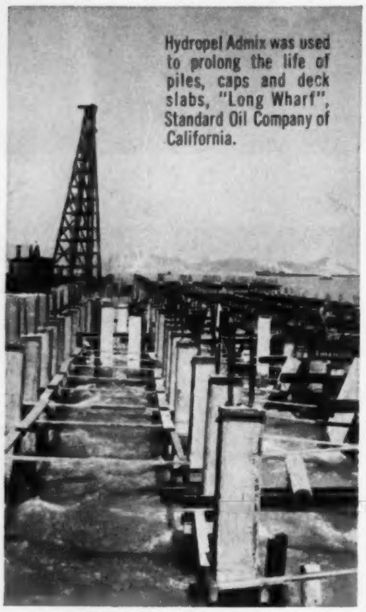
for fast, economical "first-line" protection. Laykold® Waterproofing* is a specially-compounded asphalt emulsion for cold, external application on concrete or masonry walls. Put on by brush or spray ahead of backfills, it provides resistance to moisture and dampness.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Whenever moist conditions, freeze-thaw cycles, the presence of alkaline or neutral salts require the absolute minimum of moisture absorption, always specify Hydropel®. It cuts capillary water absorption by 80 per cent.

Waterproofing and Hydropel are only two of the famous Laykold line of asphaltic products available to the construction industry. Call or write our nearest office today for full information.

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News of Engineers

(Continued from page 23)

Archie N. Carter, for the past two years vice president and treasurer of Lindsey, Carter & Associates, Inc., consulting engineers and land surveyors, has been appointed president and treasurer of the firm under the new name of Carter, Krueger & Associates, Inc. The firm is presently planning new street projects, sewage treatment plants, water supply facilities, and other municipal improvements for numerous cities and villages in Minnesota. Work by the company in these major fields of civil engineering will continue in its new offices at 3381 Gorham Ave., Minneapolis, Minn.

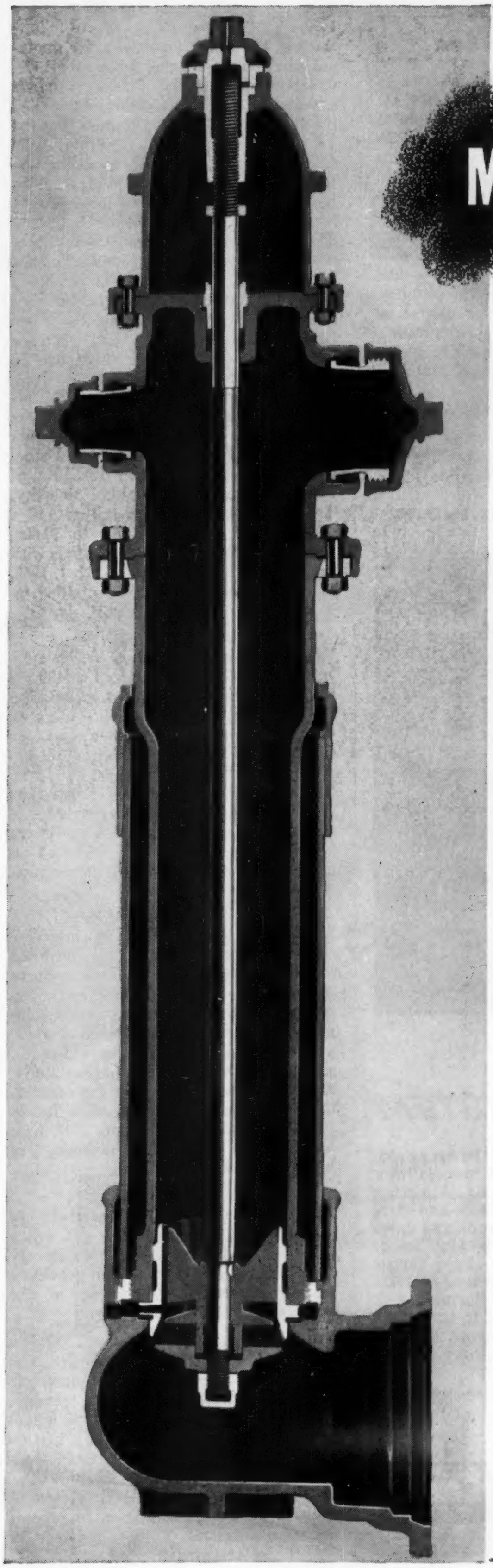
Albert Edward Stoltz, retired Colonel, U. S. Air Force, Academy Construction Agency, Colorado Springs, Colo., was honored recently with the Distinguished Service Medal, the nation's highest peacetime award, in a ceremony at the Academy. Colonel Stoltz directed supervision of all planning, designing, and building of the Academy.

Nicholas F. Forell, structural engineer of San Francisco, Calif., has formed a partnership with William M. Gillis. Mr. Forell has been associated with the U. S. Bureau of Reclamation in Denver, Colo.; Sverdrup and Parcel, consulting engineers of San Francisco; and John Lyon Reid & Partners, where he was senior engineer.

Charles Abramovitz has been admitted to partnership in the firm of Ralph L. Woolpert Company, consulting engineers of Dayton, Ohio. Mr. Abramovitz has had experience in design and supervision of subdivision developments. He teaches sanitary engineering courses at the University of Dayton.

Gordon M. Flammer has joined the civil engineering staff at Utah State University as an assistant professor. Mr. Flammer received his B. S. and M. S. degrees from Utah State and his Ph. D. degree from the University of Minnesota. He also worked at the University of Minnesota three years on research at the St. Anthony Falls Hydraulic Laboratory.

Franklin O. Rose is civil engineering consultant for a two-year term at the Ahsanullah Engineering College in Dacca, East Pakistan, as part of a contract the Texas A. & M. College has with the International Cooperation Administration. Mr. Rose spent the academic year 1957-1958 teaching at the University of Wisconsin in Madison, after completing a similar assignment for that institution at the Birla College of Engineering in Pilani, India. Mr. Rose announces that his son, **John S. Rose,** was recently appointed by Buck, Seifert and Jost, consulting engineers of New York, as resident engineer on the $8,000,000 water supply project and treatment plant at Sturgeon Point, on Lake Erie, which the firm had designed for the Erie County Water Commission.



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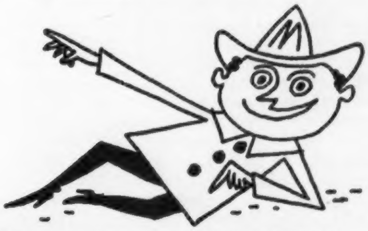
Also . . . Nozzle sections supplied with hose or pumper outlets as specified • Operating thread cannot be bent • Compression-type main valve prevents broken Mathews from leaking • Nozzle level can be raised or lowered without excavating • Bell, mechanical-joint, or flange-type pipe connections • Conventional or "O" ring packings



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Non-ASCE Meetings

(Continued from page 112)

ference, February 24-26. Eleventh Annual Illinois Traffic Engineering Conference, February 26-27. Both at the University's Urbana campus. Information from the University.

University of Utah. Twentieth Annual Highway Conference sponsored by the Department of Civil Engineering, University of Utah, Salt Lake City, Utah, March 3-4. Information from Grant K. Borg, Head, Department of Civil Engineering, University of Utah, Salt Lake City, Utah.

New in Education

Fellowships Open . . . The *Bureau of Highway Traffic at Yale University* announces fellowships will be available to qualified graduate engineers for the 1959-60 academic year. They provide a living stipend of $1,400, plus a tuition fee of $800. The Bureau also offers tuition scholarships to municipal and state highway engineers receiving financial aid from their employers while doing the graduate work. Applications for admission and additional information may be obtained from Fred W. Hurd, Director, Bureau of Highway Traffic, Yale University, Strathcona Hall, New Haven, Conn. The closing date for filing applications is March 1, 1959 . . . *Tau Beta Pi* announces fellowships of $1,500 each, available for graduate study in engineering during the 1959-60 school year. All Tau Peta Pi members are eligible. Applications must be mailed by February 28, 1959. Letters from at least two members of the faculty must be filed in support of application. For further information write to Paul H. Robbins, Director of Fellowships, 2029 K Street, N. W. Washington 6, D. C. . . . The annual search for outstanding students to receive *Daniel and Florence Guggenheim Fellowships* for graduate study in astronautics, rockets, jet propulsion and flight structures has been launched by the Daniel and Florence Guggenheim Foundation. Eighteen to twenty fellowships will be given for study during 1959-60 at the Daniel and Florence Guggenheim Jet Propulsion Centers at Princeton University and California Institute of Technology, and the Daniel and Florence Guggenheim Institute of Flight Structures at Columbia University. The fellowships provide a tuition and a stipend ranging from $1,500 to $2,000. Applicants must file their credentials with the university selected by March 1, 1959. Successful candidates will be notified by April 1.

Yale Teaching Fellows . . . Teacher recruitment at Yale has received a $120,000 spurt from the Carnegie Corporation. The new grant will permit the college to seek out and enlist ten students a year, assigning them teaching duties with an average stipend of $3,750 a year. These "Teaching Fellows," under the supervision of various Yale department heads and a central committee of professors administering the Teaching Fellows Program, will meet fortnightly for discussion and self criticism.

Short and Intensive . . . An intensive course in Automatic Control is scheduled for June 15-24, 1959 by the *University of Michigan* College of Engineering. The course objective is to present the fundamentals of automatic control and provide a comprehensive set of notes which will serve as a framework for further study. April 15 is the closing date for registration. For further information write to Prof. Elmer G. Gilbert, Room 1521, East Engineering Building, University of Michigan, Ann Arbor, Mich.

Christmas Gift . . . The *University of Wisconsin's* major Christmas gift was a $150,000 grant from the Atomic Energy Commission (AEC) which will provide a nuclear reactor for education in the peaceful use of atomic energy.

Special Classes for Teachers . . . The National Science Foundation announces that *Iowa State College* will conduct three special institutes for high school and college teachers of science, mathematics, and engineering. All three institutes will run from June 8 to July 17. The College will receive $160,000 from the National Science Foundation to support its three programs. Tuition and fees for

(Continued on page 124)

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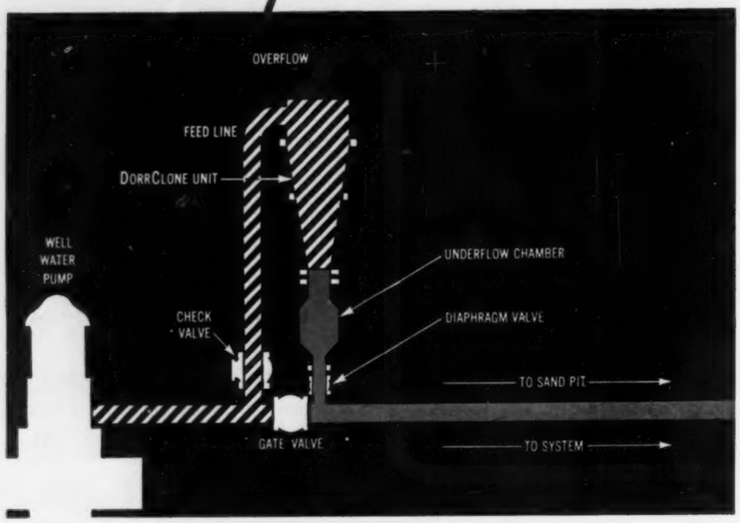

THE DORRCLONE WELL WATER DESANDING SYSTEM

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Heart of the system is the DorrClone unit, a cylindroconical shell, shown diagrammatically above. In operation, raw feed water enters tangentially under pressure at the top. A vortex action is created, throwing sand particles to the walls of the cone and down to the underflow at the bottom. Sand-free water at the center of the vortex flows out the top to storage, a treatment plant, or directly to the mains.

Units may be designed to suit practically all well water systems. For full information, write for a copy of Bulletin No. 2507.

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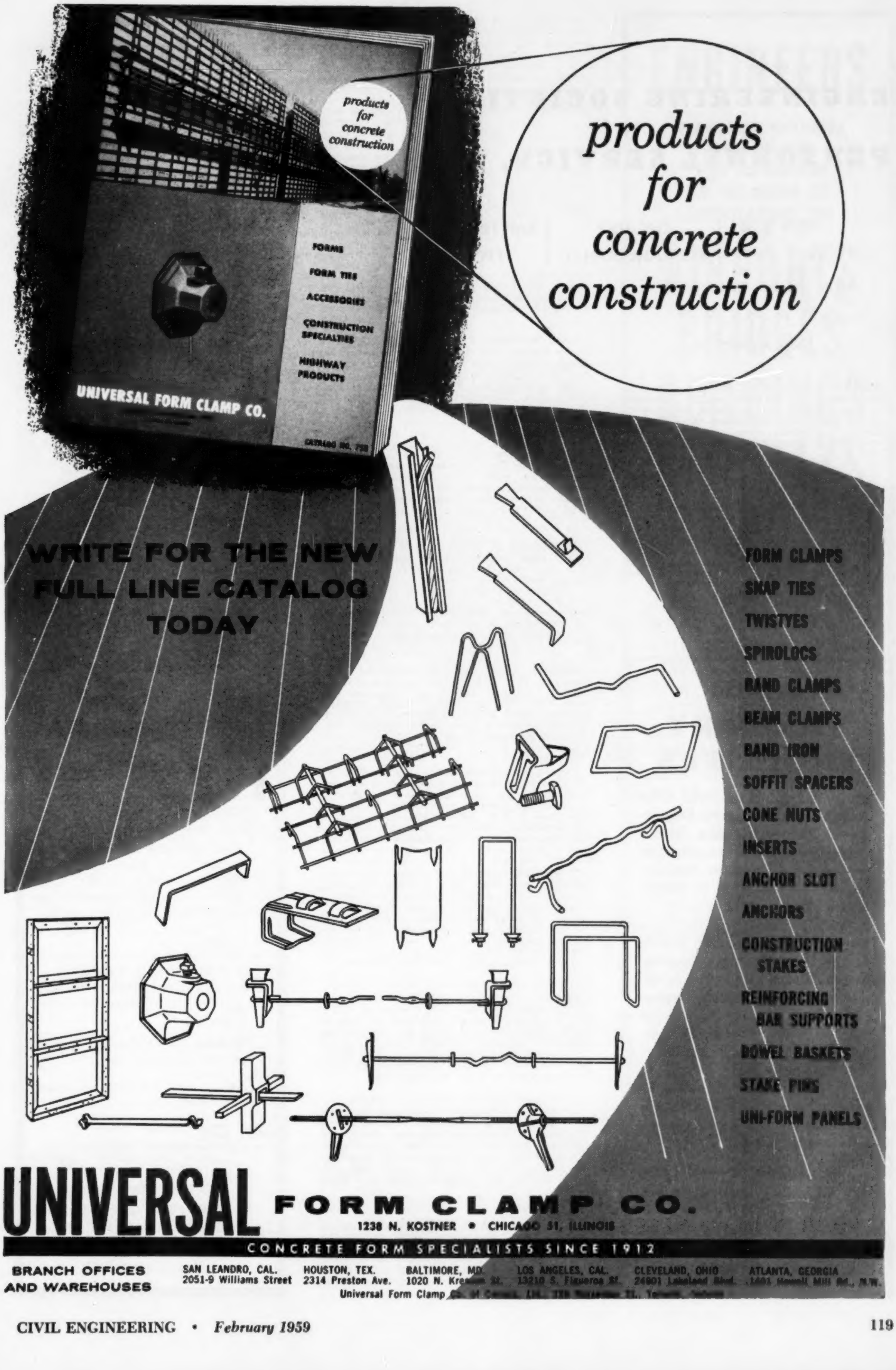
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A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for non-members, payable in advance.

Men Available

SALES MANAGER, M. ASCE, B.E.C.E., Construction Materials, 42. Licensed Georgia, Tennessee; five years' railroad bridge design, construction; last ten years' sales engineering, metal building products, bar joists, rebar, metal forms, etc., proven record. Location, Southeast to Southwest. C-418.

EXECUTIVE ENGINEER, A.M. ASCE, B.S.C.E., 40. Director of public works for five years; consultant to president of engineering firm; designed and constructed heavy commercial buildings, schools, sewage disposal plants, bridges, roads. Foreign and domestic. Speaks Spanish and some German. Engineering projects for U.S. Navy. Location desired, Europe or Domestic. C-419.

CIVIL ENGINEER, J.M. ASCE, B.S.C.E., 26. Junior engineer with the City of Cincinnati in the design section of the Sanitation Department for one year. USAF fighter pilot with secondary duties as supply and fly-a-way kit officer from 1956 to date. Has supervised personnel. Has EIT in the State of Ohio. Location desired: U.S. C-420.

CHIEF ENGINEER, ASCE, B.S. in C.E., Resident or Project, 40. Chief engineer, slipform design and construction, eight years. Administration, two years; resident engineer for two years, structural design, twelve years. Location desired: East or West coast, Latin America or Spain. C-421.

MANAGEMENT, M. ASCE, B.S., M.S. in C.E., 45. Over twenty years' service in Corps of Engineers, U.S. Army with full responsibility for planning, design, construction, operation and maintenance of all types of projects including airfields, dams, buildings, utilities, hospitals, municipal facilities, and research and development installations. Served as district engineer and contracting officer. Location desired: South or West. C-422.

STRUCTURAL ENGINEER, A.M. ASCE, M.S.C.E., registered, 35. Thirteen years' experience in design of steel, reinforced concrete and prestressed concrete, heavy structures, bridges, tunnels, industrial and commercial buildings. Desires to work with engineer or architect firm in San Francisco area. Presently empolyed. C-423.

CONSTRUCTION ENGINEER, M. ASCE, B.S.C.E., 49. Twenty five years as project manager and resident engineer on industrial, sanitary, powerplants, buildings and municipal construction. Background experience in large A.E.C. projects. Experienced as administrator estimator, contracts negotiator and supervision of work. C-424-923-Chicago.

PLANNING OR CONSTRUCTION ENGINEER, M. ASCE, B.S.C.E., 65. Seven years' overseas supervising planning, designing and construction of irrigation, flood control and multiple purpose projects including ground water investigations. Thirty six years in U.S. planning designing, constructing and operating irrigation projects. Supervised construction of power house. Location desired: Pacific Coast or Southern U.S. C-598-San Francisco.

SUPERVISORY ENGINEER, M. ASCE, B.S.C.E., 55. Thirty years' experience, civil engineering. Qualified as project manager or project engineer on major design and construction projects including industrial buildings, airfields, hangars, shops, housing, roads, streets, bridges, utilities plants and distribution systems. Location desired, West, South or Foreign. C-459-San Francisco.

JUNIOR CIVIL ENGINEER, DRAFTSMAN, SURVEYOR, J.M. ASCE, B.S.C.E., 32. Four years with State of California, Division of Highways, Bridge Department. Did drafting and field estimating for overpasses and did surveying and field inspection. Worked for the City of Los Angeles, two years doing drafting and surveying. C-583-San Francisco.

SALES ENGINEER, A.M. ASCE, A.B. Architecture, 61. Ten years' professional work; twenty two years' sales engineering, including design and estimating, bidding, and contracts for architectural and structural products, steel buildings and appurtenances. Location, San Francisco Bay area. C-609-San Francisco.

Positions Available

ENGINEERS. (a) Sanitary Engineer, experienced in the design of sewage treatment works; would also be required to work on water treatment plants and other projects in the water and sewerage fields. Salary open. Location, upstate New York. (b)Engineer's Assistant for the layout and inspection of sewer construction. Salary open. Location, vicinity of Poughkeepsie, N. Y. W-4747.

TEACHING PERSONNEL in engineering, mathematics, physics and chemistry. Program of development includes strengthening Faculty, inaugurating a graduate program and designing a new science and engineering building. Location, Middle East. F-6237.

FIELD OFFICE AND COST ENGINEER for construction

SENIOR SANITARY ENGINEERS

Positions available with the New York State Health Department. Performs public health engineering work either as an engineer in charge of environmental sanitation in a public health district or as assistant to a central office specialist in a major segment of a public health engineering program. Requirements: Bachelor's Degree in engineering, progressively responsible engineering experience with at least two years in sanitary or public health engineering. Eligibility for a New York State professional engineers license. Salary $7,500-$9,090. Final date for filing for exam, February 23, 1959.

For application write MR. SYLVESTER J. BOWER, *Acting Director of Personnel*, New York State Health Department, 84 Holland Avenue, Albany, New York.

Hydro Engineers

Interesting positions for CE's with 5–10 years' hydro experience including field studies involving dam sites, and plant locations; hydro studies; economic analysis; specification preparation on hydro plants; and improvement of existing facilities.

These positions are based in our NY Headquarters but will involve field trips to Latin America.

Knowledge of Spanish desirable but not essential.

Salary commensurate with past experience.

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company specializing in industrial buildings. Must have knowledge of costs and estimates in general construction and be willing to reside where jobs are located. Two openings at present—one in northern New Jersey, the other in Cincinnati, Ohio. Salary, $8,400-$9,600 a year. W-6701.

STRUCTURAL ENGINEER, Master's or Ph.D. degree, with considerable experience, for a prominent consulting engineering firm. Location, Midwest. W-6726.

TRAINEES, graduate mechanical or civil, for multi-plant operation for the manufacture of cement, lime, refractory and related products. Salary, about $6,000 a year. Location, Midwest. W-6729.

GENERAL CONSTRUCTION BUILDING SUPERINTENDENT, with considerable experience in general building construction. Must be able to coordinate the field operations of fifteen to twenty field superintendents, and be capable of working under pressure to deadline dates. Salary, $15,000 a year, minimum. Headquarters, New York, N. Y. W-6793.

ESTIMATOR, experienced in concrete structures, grouting, foundations and concrete design. Outstanding opportunity with nationwide contractor. Location, Ohio. W-6794.

STRUCTURAL ENGINEER, graduate civil, with some experience, to do design and detailing on industrial buildings, bridge and grade separation work and general highway facilities. Will also include quantity and cost estimates and other related work. Some travel. Salary open. Location, Louisiana. W-6798.

STRUCTURES ENGINEERS, aircraft, with five to ten years' experience. (1) Pre-design and analysis of basic airframes. (2) Responsible for structural design loads. (3) Design criteria for preliminary design and/or project design. Salaries, $9,000-$12,000 a year. Location, New York State. W-6815.

CIVIL ENGINEER, graduate, with outstanding record and experience in building construction, for excellent, diversified position with general contractor. Location, New York, N. Y. W-6866.

SENIOR HIGHWAY AND BRIDGE ENGINEERS, with ten years' supervisory design, field and construction engineering experience. (a) Chief Engineer. Salary, $18,000 a year. (b) Assistant chief engineer. Salary, $15,000 a year. (c) Bridge engineer. Salary, $13,500 a year. (d) Construction engineer. Salary, $13,500 a year. (e) Design engineers, with five years' experience. Salary, $9,000 a year. Subsistence allowance in addition to salary. Two-year contract. Location, Middle East. F-6873.

CONSTRUCTION SALES MANAGER, graduate engineer, preferably from M.I.T., or similar school, with outstanding sales and management ability. Excellent opportunity with well established building contractor. Location, New York, N. Y. W-6875.

FIRE PROTECTION ENGINEER, with mechanical, electrical or civil engineering degree and field experience, for position with insurance firm. Salary, $5,000-$6,000 a year. Some traveling. Location, New York, N. Y. W-6879.

ARCHITECTURAL DRAFTSMAN with three to five years' experience for small commercial and some industrial buildings. Experience in field and estimating would be desirable. Salary open. Location, New York State. W-6905.

OFFICE ENGINEER, graduate, basically structural for large contractors on industrial plants, schools, hospitals, etc. Salary open. Location, Maryland. W-6920.

CIVIL ENGINEER, graduate, with three to five years' experience in municipal utilities. Work will be in the design of structures, water supply and distribution systems, water treatment, sewers, pumping stations and sewage treatment facilities. Salary open. Location, West. W-6926.

DIRECTOR OF RESEARCH AND DEVELOPMENT, C.E. graduate, with at least M.S. degree in soils engineering or allied science to take charge of laboratory field engineering, covering soils, seepage, pumping and general foundation investigations. Salary, $10,000-$15,000 a year. Location, New York, N. Y. W-6931.

TEACHING PERSONNEL. (a) Department head for civil engineering department, Ph.D., with university and administration experience and ability to initiate and develop research and graduate work. Salary, $8,500-$14,500 a year. (b) Lecturer or Professor to teach and do research in soil mechanics and transportation engineering. Salary dependent on qualifications. Medical, hospital and pension plans in effect. Rapidly developing graduate study and research program. Location, Canada. F-6944.

JUNIOR CIVIL ENGINEERS, B.S., with one to two years' preferably in irrigation and water distribution, for design office work, under registered engineer. Salary, $6,000 a year or more, depending on experience. Location, San Joaquin Valley. S-3850.

CIVIL ENGINEER, P.E., B.S. or equivalent. With experience in flood control and hydro electric planning. Employer will pay placement fee. Salary to start, $7,510 a year. Location, Northwest. SG-4003 (a).

ENGINEER, Assistant civil or hydraulic, B.S. or equivalent, with four years' experience in office and field, qualifying to plan and direct design and drafting, specifications and estimates for construction of maintenance for various municipal public works; also plan and direct field surveys and inspections. Reports to City Engineer. Salary, $6,036-$7,344 a year. Location, Monterey County. SG-4005.

OFFICE ENGINEER, Heavy Construction, C.E., with both field and office experience related to heavy construction of dams, tunnels, water supply, waterfront, for designing and estimating costs of construction facilities. Salary open. Some traveling. Location, San Francisco. S-4008.

DESIGN ENGINEER, Consultants, E.E., M.E., C.E., with experience equivalent to that required for registration for water supply, drainage and sanitary problems. Salary, $7,800-$8,400 a year. Location, San Francisco. S-4027 (c).

DESIGN ENGINEER, Mechanical Structures, M.E. or C.E., with emphasis on structural design of mechanical components of remote controlled special handling devices. Requires knowledge of mechanics of materials, universal joints, etc. Salary, $7,800-$8,400 a year. Location, Oregon. S-4031.

CHIEF ENGINEER, Petroleum, M.E., E.E. or C.E., plus advanced work in petroleum engineering. Requires experience as chief or assistant chief engineer or chief project engineer in charge of large engineering projects; able to plan and organize engineering projects and provide direction for design, construction and maintenance of facilities—power plants, oil transportation and storage. Will be senior technical adviser to vice president and general manager. Salary, $18,000-$20,000 a year. Two year contract—renewable. Location, Persian Gulf. S-4040.

SALES ENGINEER, Earthmovers, preferably C.E. or equivalent, with broad knowledge of earthmoving equipment and wide acquaintance with contractors in Northern California, to promote and develop sales of manor line of shovels, graders and tractors. Staff position; attractive pay for producer. Headquarters, San Francisco. S-4056.

ENGINEERS for water service company. (a) Senior Design Engineer, graduate with a minimum of ten years' experience in design drafting—water works structural, equipment facilities, architectural; construction—methods, materials, layout, inspection, estimating, supervision; design calculations—strength, capacities, hydraulic, gradient, pumps, electrical, pipe sizing, equipment testing. Salary, $10,000 a year (b) Senior Distribution Engineer, graduate, with a minimum of ten years' experience on rights of way—court house records, maps, etc.; permits—highways, railroads, municipal, U. S. Engineers, Public Land Corp.; hydraulic-flow test for "C" values, pitometer flows, hydraulic preparation of plans, specifications, contract documents, etc.; miscellaneous—underwater pipe lines, leak location, main repairs, main cleaning, etc. Salary, $10,000 a year. Location, South. W-6962

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Applications for Admission to ASCE

Nov. 29, 1958-Jan. 3, 1959

Applying for Member

James Thomas Anderson, New York, N. Y.
Robert Dittmar Bargman, Palos Verdes Estates, Calif.
Max Bernheimer, New York, N. Y.
Jack Bailey Blackburn, St. Louis, Mo.
Frank Lee Blue, Jr., State College, Pa.
James Hatton Brindel, Jr., Arlington, Va.
Harold Phillips Brooks, Columbus, Ohio
Morris Harliston Cressman, New York, N. Y.
Robert William Darcenzo, Richland, Wash.
Harold James Dickinson, Denver, Colo.
Walter John Douglas, West Hartford, Conn.
Henry Hartley Edwards, Lakeland, Fla.
William Elmer Feidt, River Edge, N. J.
John Edwin Foreshew, Washington, D. C.
Gordon Karl Gravelle, New York, N. Y.
George Homer Hamlin, San Leandro, Calif.
David Harold Hancock, Greenville, N. C.
McCown Edward Hunt, Salt Lake City, Utah
Virgil Calvin Jewell, Santa Fe, N. Mex.
Chester Elmer Kuhn, Ralston, Nebr.
David Joseph LaKome, Houston, Tex.
Edward Albert Lejeck, Pittsburgh, Pa.
Kenneth Carl Lovell, New York, N. Y.
Robert Orville Maxson, Washington, D. C.
Thomas Gleason Mooney, Juneau, Alaska
Hubert Laurince Morgan, Oak Harbor, Wash.
Henry Joseph Ongerth, Berkeley, Calif.
William Winsor Peterson, New York, N. Y.
Aris Phillips, New Haven, Conn.
Carleton Edward Plumb, Sacramento, Calif.
Robert Alfred Sharood, Jalisco, Mexico
William Harry Smith, Chicago, Ill.
Donald Eugene Stein, Spokane, Wash.
Albert Waters Stone, Chattanooga, Tenn.
Hans Leo Streibel, Niagara Falls, Ont., Canada
Karl Jarolin Svaty, Wichita, Kans.
Shigeru Tanaka, Urbana, Ill.
Garret Carper Tewinkel, Silver Spring, Md.
Roy Henry Tokerud, Salem, Ore.
Russell Vinsonhaler, McCook, Nebr.
Arthur Barthen Wilder, Pittsburgh, Pa.
Charles Hopkins Zweifel, Alameda, Calif.

Applying for Associate Member

Tevfik Aki, Cornwall, Ont., Canada
Ira Henris Alexander, Los Angeles, Calif.
Philip Lyle Bentley, Sr., Birmingham, Ala.
Clarence Vincent Burns, Topeka, Kans.
Thomas Aquinas Considine, Baltimore, Md.
Jacobus DeRuiter, Niagara Falls, Ont., Canada
Norman Arthur Dixon, Walla Walla, Wash.
Dallas Isaiah Downs, Los Angeles, Calif.
Mateo Lian-Pao Go, Syracuse, N. Y.
Alfred Goldberg, San Francisco, Calif.
Alexander Murdoch Gow, Kansas City, Mo.
Norman Hobbs Gray, Riverside, Calif.
William Joseph Hannigan, New York, N. Y.
Denis William Patrick Hayden, Moghalsarai, India
Howard Richard Holley, Jr., Atlanta, Ga.
Robert Bruce Hope, Los Angeles, Calif.
Ivan Clark Justice, Kansas City, Mo.
Vaswani Naraindas Kalachand, Madison, Wisc.
Mohsin Ali Khan, Washington, D. C.
Francis Denis Light, Harrisburg, Pa.
Robert Henry Livesey, Omaha, Nebr.
Frank Wilson McHenry, Warren, Pa.
Eugene Wilbur Miller, Los Angeles, Calif.
Frank Kenneth Morse, Portland, Ore.
James Reed Nevins, Tulsa, Okla.
George Dimitri Nichols, Detroit, Mich.
Vernon George Piette, Sr., El Paso, Tex.
Juergen Ludwig Plaehn, Jacksonville, Fla.
Walter Shipman Proctor, Jr., Bangkok, Thailand
Victor Arthur Rouillard, Concord, N. H.
John Joseph Sewell, Saudi Arabia
Keith Edgar Shirk, Des Moines, Iowa
Delbert Ray Smith, Urbana, Ill.
Paul Lawrence Streb, Providence, R. I.
George Gregory Tedaldi, New York, N. Y.
Noel Miranda Torres, Tacoma, Wash.
Alexander Veremeev, Queensland, Australia
Vito Antonio Villani, Rome, Italy
John Andrew Ziemian, Newark, N. J.

For Affiliate Member

Fairfield Harry Elliott, St. Louis, Mo.
William Edward Lieberman, Los Angeles, Calif.

Applying for Junior Member

Gary Dale Adams, Dallas, Tex.
Mavally Narayanaswamy Appayanna, Bangalore, India
Frank Anthony Balestreri, Milwaukee, Wisc.
Allan DeWitt Beck, Providence, R. I.
Harold Joseph Fredrick Bergsten, Jr., Topeka, Kans.
Naranjan Singh Bhalla, Punjab, India
Donald Wright Carraway, Atlanta, Ga.
John Melvin Clark, Jr., State College, Pa.
Joseph Alfred Cribello, Jr., Baltimore, Md.
Enrique Eduardo Danies, Cleveland, Ohio
John Charles Durborow, Jr., High Spire, Pa.
Hardy Ewald Fairbanks, College Station, Tex.
Kenneth Donald Hansen, Denver, Colo.
William Lawrence Hickerson, Louisville, Ky.
Stanley Wilcott Hole, Miami, Fla.
Bradley John Honholt, Urbana, Ill.
Luigi Iori, Ozone Park, N. Y.
Maximiano Romualdez Janairo, Jr., Urbana, Ill.
Larry Uno Larson, Rockford, Ill.
Marvin Melvin Marsh, II, Jackson, Mich.
Robert McGrath Marshall, Los Angeles, Calif.
Eduardo Alfredo Mier-Y-Teran, Caracas, Venezuela
Faramarz Moavenzadeh, Ithaca, N. Y.
William Joseph Mouton, Jr., New Orleans, La.
Ronald Douglas Pacchiana, Bronxville, N. Y.
Lewis Wayne Patrick, Irving, Tex.
Floyd Holmes Pattison, Jr., Manhattan, Kans.
Eben Harrison Sales, Easton, Pa.
Walter Warren Seaman, Chillicothe, Ohio
Maynard Elmer Schuur, Gary, Ind.
Marcel Spichiger, Chicago, Ill.
John William Stielper, North Linthicum, Md.
Owen Guion Thomas, Jr., Birmingham, Ala.
Milton Edward Volker, Baltimore, Md.
George Thompson Will, Toronto, Ontario, Canada

[*Applications for Junior Members from ASCE Student Chapters are not listed.*]

Catherine had NO BATHTUB

Catherine de Medici, luxury loving queen of France, moved her court 90 times in 6 years so that the filthy rooms could be cleaned. The royal palace contained no water pipe nor bathing or washing facilities. Today in the United States, over 80% of homes have bathtub or shower, over 86% have inside toilet.

The American people are using water at greater consumption rate than any other people in all history. Over 250 billion gallons are withdrawn daily from ground, lakes and streams for all uses—an increase of 34% in five years. With population increasing faster than any other Nation on earth, it is estimated that by 1975 there will be 227 million Americans who will require 50% more water than they use today!

The men who build, manage and maintain America's water distribution systems are wide awake. They are aware of future problems and are planning ways and means to meet them.

This Series is an attempt to put into words some appreciation of the water works men of the United States.

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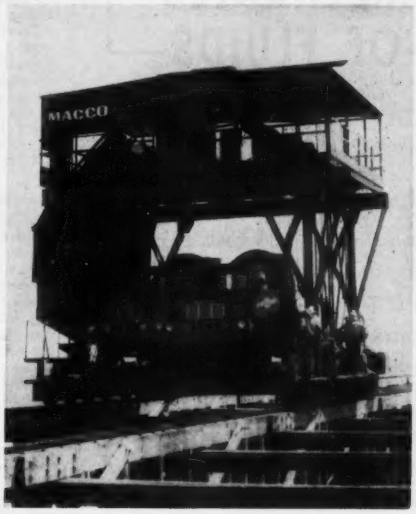

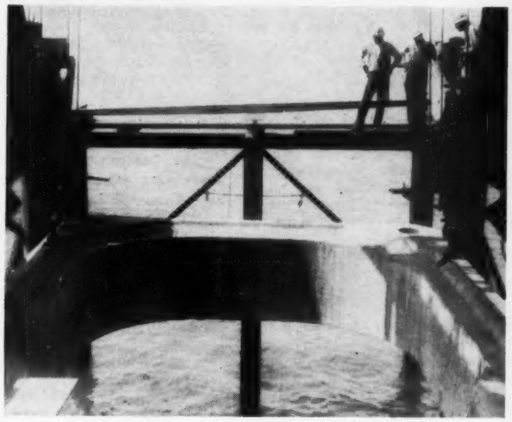

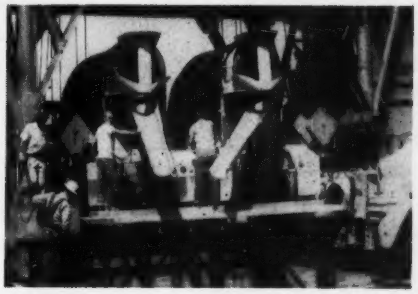

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Recent Books

(Continued from page 114)

Illustrierte Technische Worterbucher
Band 1. Maschinenelemente

This book is the first volume of a technical dictionary in German, English, Russian, French, Italian and Spanish and treats of machine parts. Entries are printed in a classified arrangement with brief definitions in each language, and illustrative diagrams for most words. There is an alphabetical key for each language referring to page and to entry numbers. This is a reprint of the third edition 1938, which has been out of print for some years. (By Alfred Schlomann. R. Oldenbourg Verlag, Munich, Germany, 1958. 438 pp., bound. 46 D.M.)

Man the Maker

A history of technology and engineering in which power resources, transportation, communication, metallurgy, textiles, glass, chemical technology and some aspects of civil engineering are covered. The inventions of prehistory, of the Ancient East, the Greeks and Romans, the Arabs, the Middle Ages, the sixteenth and seventeenth centuries, the Industrial Revolution, and the modern era are also discussed, as are the relationships of the inventors to each period. (By R. J. Forbes. Abelard-Schuman, Inc., 404 Fourth Avenue, New York 16, N. Y., 1958. 365 pp., bound. $5.00.)

Manual of Structural Design
Fourth Edition

A manual providing a wide variety of tables and methods of calculation used in structural design. This edition contains entirely new information on concrete joist, slabs, flat slabs, stirrups, concrete columns, footings, and retaining walls. The steel beam tables are entirely revised and new tables have been added on long span joist, compound sections, and fireproofing. (By Jack Singleton. H. M. Ives & Sons, Inc., P.O. Box 1398, Topeka, Kan. 1957. 272 pp., bound. No price given.)

Nuclear Reactors for Power Generation

Intended for engineers who are closely associated with the building and operation of nuclear power plants without necessarily being responsible for their design. An introductory section on world energy requirements in relation to nuclear energy programs is followed by sections on nuclear physics, types of reactors, materials, the physical basis of reactor design, safety and instrumentation, and applications and economics. (Edited by E. Openshaw Taylor. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., 1958. 144 pp., bound. $7.50.)

Refuse Collection Practice
Second Edition

A practical manual covering the various aspects of the problems involved: the kinds and amount of community refuse materials and their preparation for collection; costs, methods, and equipment; planning the collection systems; municipal, contract, or private collection; and the management problems of financing, organization, personnel, equipment management, reporting, cost accounting, budgeting, and public relations. This edition represents a thorough revision of most of the sections of the manual. (Prepared by the Committee on Refuse Collection, American Public Works Association. Public Administration Service, 1313 East 60th Street, Chicago, Ill., 1958. 562 pp., bound. $8.00.)

The Practice of Sanitation
Third Edition

A text that provides a guide to environmental sanitation for health officers, nurses, and students in sanitary engineering. In this edition the following chapters have been completely rewritten: food sanitation, milk and milk products, public water supplies, urban and rural sewage disposal, stream pollution, housing, air pollution, and industrial sanitation. (By Edward S. Hopkins and William H. Schulze. The Williams & Wilkins Company, Mount Royal Avenue, Baltimore 2, Md., 1958. 487 pp., bound. $8.00.)

The Contemporary Curtain Wall: Its Design, Fabrication, and Erection

A manual covering various aspects of curtain wall systems. It analyzes and evaluates the walls, their functions and malfunctions, component parts, materials and installations. Tables and lists give known data on insulating efficiency, fire resistance, dimensional stability, and similar factors. Pitfalls are pointed out, known solutions outlined, and accepted good practice specified. Many drawings are given to show construction details, and photographs are included to illustrate contemporary examples of the curtain wall. (By William Dudley Hunt, Jr. F. W. Dodge Corp., 119 West 40th Street, New York 18, N. Y., 1958. 462 pp., bound. $12.75.)

New in Education

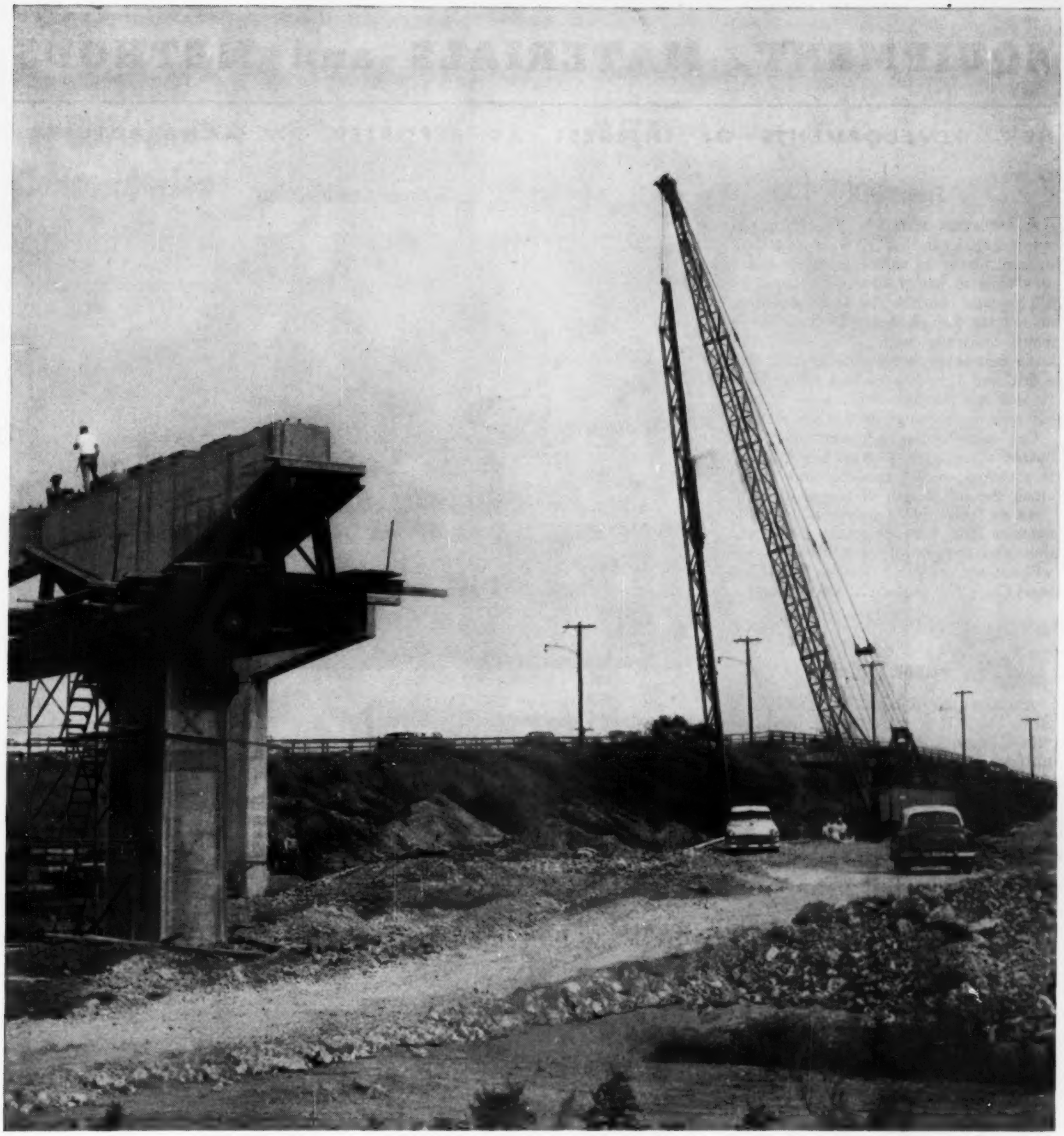
(Continued from page 118)

the teachers will be paid from these funds. Application should be made to J. A. Greenlee, 12 Beardshear Hall, Iowa State College.

Reactors for Peace . . . The *Atomic Energy Commission* has approved grants totaling $2,264,965 to 41 universities and colleges for the purchase of laboratory equipment to expand nuclear education programs in the physical sciences and engineering. Seven engineering institutions will use their funds for the purchase of teaching reactors. These institutions are the University of Illinois, Kansas State College, University of Maryland, University of Texas, University of Washington, West Virginia University, and University of Wisconsin. The awards mark the fifth in a series of grants under the Commission's program to train men for the atomic energy field.

For Military Personnel . . . Civil Engineer Corps officers, enlisted personnel, and career government employees who are interestd in advancing their professional status may wish to take advantage of a new extension course series offered to them by the *U. S. Army Engineer School*, Fort Belvoir, Va. This new series, titled "Professional Engineer Preparatory Course," is designed for those who wish to obtain professional recognition as registered engineers. There is no fee for the series. Its announced purpose is "to assist recently graduated engineers and practicing engineers in the military or government service in their review of the fundamentals of engineering in preparation for the professional engineer examinations for the engineer-in-training (EIT) certificate or the professional engineer (PE) license."

Toward Better Schools . . . The *Ford Foundation's* appropriation of $4,500,000 to establish "Educational Facilities Laboratories" is justified by an anticipated $40 billion expansion in educational facilities within the next ten years. The Laboratories will be concerned with research in improved construction of school and college buildings, and will also serve as a clearing house for data on school design, building, and equipment.



Driving unspliced H-piles up to 94 ft long

Some of the longest unspliced lengths of steel H-piles ever used in the Buffalo area are being driven for the southern approach to the $11 million, 1.5-mile-long Union Ship Canal Viaduct at Buffalo. The Viaduct will relieve a congested industrial area by providing four lanes of concrete highway.

Steel H-piles up to 94 ft long were driven with a crane having a 123 ft boom, and operated by Bero Construction Corporation of Waterloo, N.Y. In all, several thousand tons of Bethlehem H-piles were required for the piers. The Viaduct is being erected by the New York State Department of Public Works.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Space Drill

A VERSATILE MACHINE HAS been developed that can drill 18 holes at a time in steel plates up to 3½ in. thick and 9 at a time in heavy structural shapes.

This new contribution to automation, named the Lehigh Space Drill, is like a giant centipede with 27 flexible drill arms that range by remote control over a drill bed 12½ ft wide and 120 ft long. It also has two speeds: low is 15.8 in. per minute; and high is 65 ft per minute.

One man guides its operations, push-button style, from a panel board which is attached to the machine and moves along the full length of the drill bed.

As an example of its versatility, the machine can simultaneously work the web and flanges of a rolled H-shape without repositioning. **Lehigh Structural Steel Co., CE-2, Station A, Allentown, Pa.**

Vapor Boiler

AVAILABLE IN 6 DIFFERENT SIZES from 20 to 150 B.H.P. to meet any need, the "Kwik-Steam" Vapor Boiler produces full steam pressure in two minutes time and reduces both labor and operating cost by producing steam only when it is needed. The unit's compact size and light weight occupies less space in the boiler room and permits the unit to be located closer to the source of use. This same compact size allows ease in installation; the unit can easily be moved through doors and up and down elevators without difficulty.

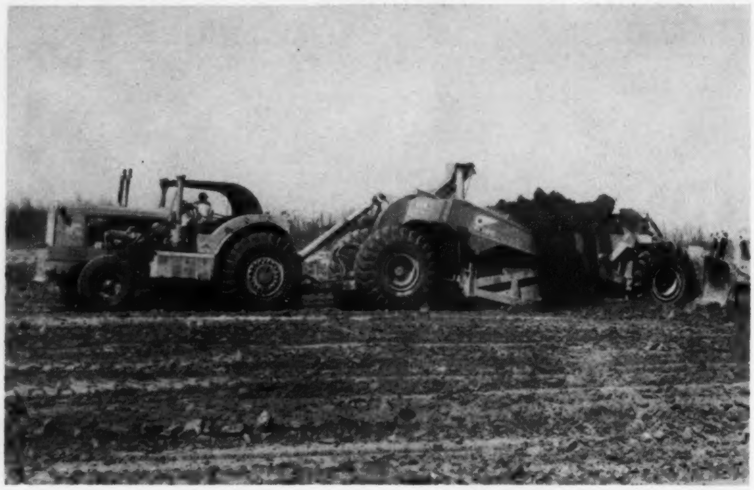
Engineering features include a patented pressurized combustion space which gives one million B.T.U. per hour in each cubic foot of combustion area. All hot gases pass over the entire coil surface giving complete combustion. High heat differential and turbulent flow of water in coils produce 78 to 82% operating efficiency. **Littleford Bros., Inc., CE-2, 457 East Pearl St., Cincinnati 2, Ohio.**

Guard Rail

A NEWLY DESIGNED, LOW-COST, easy-to-erect and maintain Shallow Beam Guard Rail for commercial and secondary highways is available in 9 and 12 gauge.

Shop curved uniformity and pre-fitted drilled holes and slots mean quick, labor-saving erection. Maintenance is also less expensive because superior finish (phosphatized—equal to bonderizing—baked-on, rust-inhibitive lead chromate) lasts longer. Protecto posts are also available to meet every possible installation requirement. **The Syro Steel Co., CE-2, Girard, Ohio.**

Scraper Combination



CONSISTING OF THE 250 TRACTOR and the hydraulic powered 250 HW Scraper, this giant hauling rig is designed for extra high production per hauling unit to provide minimum cost per yd of production.

The 600-hp 250 Tractor provides ample power to tow the big scraper at speeds up to 34 mi per hour with a substantial power reserve for maximum gradability. With big, low pressure drive tires plus the extra traction producing Hydraulic Weight Transfer feature, the huge tractor provides a high degree of drawbar effort to assist the pusher equipment to load the 38 cu yd scraper in minimum time and distance.

Operating efficiency is maintained at a high level by the extra riding comfort made possible by the four-wheel tractor and is further increased by such advanced features as the air assisted clutch and the semi-automatic constant mesh transmission with a well spaced selection of nine forward and two reverse speeds. **M-R-S Mfg. Co., CE-2, Flora, Miss.**

Truck Crane

PRODUCTION OF A NEW 30-ton lorry crane has been announced. Called the Type WT, the crane can be supplied with three different truck mountings to meet varying axle load requirements of the various states. The 30-ton truck carrier is 9 ft wide and the 25-ton truck carrier is offered in both 8 and 9 ft widths.

The WT features an 8-ft wide deck with all operating machinery mounted low and well back of the center line of rotation. Machinery deck and sidestands are constructed as one-piece weldment. Bearing housings are line bored to insure accurate alignment. Power is transferred from the engine clutch to the operating machinery by a four strand roller chain drive.

All shafts are of high strength alloy steel with involute splining for added strength. Anti-friction bearings are used on high speed shafts. Clutches are internal expanding type designed to meet the most rugged service requirements. Mechanical controls with booster actuated drum clutches provide positive, easy operating controls for accurate load handling. **Insley Mfg. Corp., CE-2, P. O. Box 167, Indianapolis 6, Indiana.**

Arrow Template

DESIGNED TO FACILITATE THE WORK of the map-maker, the town, city and subdivision planner, the highway engineer, the architect and the pipeliner designer, the No. 53 Arrow Template contains varied sizes and designs of arrows and north indicators and two sizes of traffic and road-sign markers.

Made of .030 mathematical quality plastic, the cut-outs are precision milled for smoothness of line and ease in drawing. The overall size of the template is 6 in. x 4 in. **Rapidesign, Inc., CE-2, P. O. Box 429, Burbank, Calif.**

Unmatched for Efficient Consolidation Soil Testing...

OLSEN

K-W Conbel

- Infinite choice of loads
- Load applied instantly without shock
- Capacities from 750 lbs. to 10,000 lbs.
- Simplified controls—one man operation
- Air operated—no dead weights
- Compact . . . light weight . . . portable

For information about the Conbel and other modern K-W soil testing equipment for triaxial, unconfined compression, and direct shear testing . . .

Write for Bulletin 50-A

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The twenty five papers presented at the Conference on Electronic Computation, exactly as delivered at the Conference, are being offered in a single paper-bound volume.

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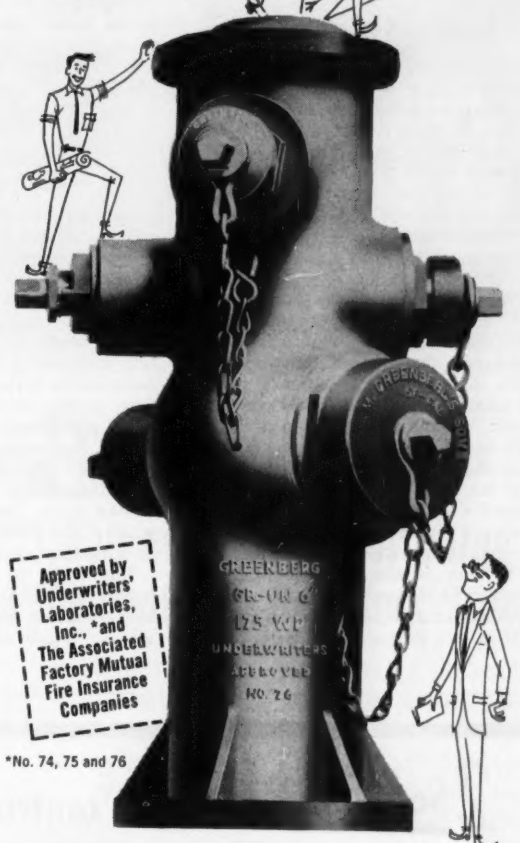
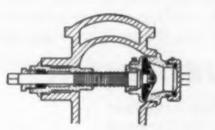


GREENBERG

California type HYDRANTS are preferred everywhere!

The most widely preferred design throughout the Western States, Panama, South America, Hawaii, the Philippines, South Pacific and Saudi Arabia. These improved hydrants have received the endorsement of fire chiefs, waterworks superintendents and engineers everywhere.

SPECIFICATIONS



- FAST BREAKING VALVE DESIGN
  Seat angle provides maximum efficiency, minimum resistance, quick opening and full flow of water. Eliminates water hammer and valve chatter at full 200 lbs. working pressure.
- Independent valve for each outlet
- Full 6¼" waterway
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Offices in Principal Cities throughout the United States

Intake and Pump House

DESIGNED TO SUPPLY APPROXIMATELY 5,000,000 gallons of water daily, an intake and pump house will provide service for the new Cities Service Co. Ltd. refinery near Bronte, Ontario.

Located about 50 ft from the edge of Lake Ontario, the pump house is a reinforced concrete structure, approximately 30 ft square and 32 ft deep; travelling screens are installed in the pump house wall at the intake level.

From the bottom of the pump house, 1800 ft of 30-in. diameter, subaqueous concrete pipe extends out into the lake. Supported by sacks of concrete placed by divers, the pipe rests in a trench drilled and blasted out of the solid shale lake bottom. As much as 20 ft deep at the pump house end, the trench is 4 ft deep at its shallowest.

At the lake end, the company constructed a 10-ft square intake crib. The opening, a funnel-shaped aperture 6 ft in diameter at its widest point and narrowing to 30 in., is protected by a 6-in. concrete slab which rests on top of the intake crib. On each side of the crib is a 48-in. by 15-in. slot, through which water passes to the intake opening. The intake crib structure is submerged at least 20 ft below lake level. **Dravo of Canada Ltd., CE-2, 159 Bay St., Toronto 1, Ontario.**

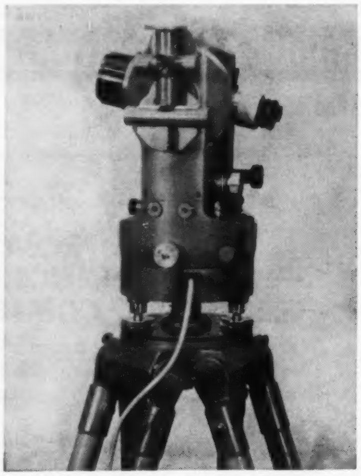
Electronic Tracer

SIMPLE PENCIL LINE SKETCHES of intricate shapes and forms can now be used to guide oxygen shape-cutting machines. A new electronic tracer has been introduced that makes it possible to use easy-to-prepare pencil or ink line drawings to control single or multi-torch flame-cutting machines. A built-in automatic kerf compensator makes it possible to reproduce one or thousands of complicated metal parts easily and with extreme accuracy from exact size drawings. Automatic kerf adjustment represents a radical improvement over existing types of tracing units. Parts can be reproduced without the necessity of making allowance for kerf width on the drawing.

Known as the Photocell Tracer, the new unit eliminates the need for expensive metal or plastic templets, photographic negatives, or complicated and costly silhouettes. And there is no need to make allowance for kerf width on drawings. Drawings of parts are made in the exact size of the part desired. The kerf compensator dial is then set for the plate thickness being cut and automatically compensates for kerf width so that reproduced parts are exactly the same size as the line drawing. **Linde Co., Div. of Union Carbide Corp., CE-2, 30 E. 42nd St., New York 17, New York.**

Tavistock Theodolite

READING DIRECTLY TO ONE second of arc, the Tavistock Theodolite Type 11 is equipped with an internal focusing telescope, spirt levels, centering device and optical plummet for centering over ground mark. It can be supplied with telescopic or non-telescopic tripod with press-down feet and leather strap, and is packed in special fittings in a metal case.



Internal Focusing Telescope

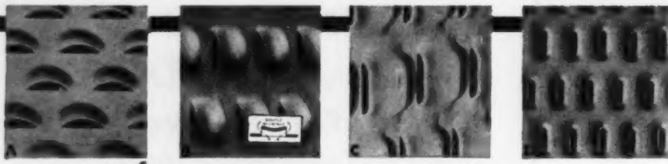
Horizontal and vertical circles are graduated every 20 min on glass annuli. A single optical micrometer is provided for both circles, the circle reading eyepiece beng situated parallel to the telescope. A control on the standard enables the observer to select which circle is to be viewed. **Precision Instruments, Inc., CE-2, 1900 Fifth Ave., Troy, N. Y.**

Hydra-Lift

PRINCIPAL FEATURES OF THE Model 50 Hydra-Lift are: the machine lifts up to 5,000 lb; it requires only 22 in. behind a truck cab; it is completely hydraulic;

(Continued on page 129)

2 Solutions to water control problems



1. DEPENDABLE SOURCE...

The finest well is only as efficient as its casing. Today you can put down casing designed to meet your exact requirements...based on formation, soil analysis, water levels, seasonal conditions, etc.

Thompson Pipe & Steel makes well casing of all kinds and sizes...from 4" to 36" diameters, black or hot dipped galvanized mild steel, STAINLESS, Monel, Everdur and nonferrous metals. A variety of perforations and field joints to choose from. Get the *right* casing from Thompson Pipe & Steel Company.

2. ACCURATE MEASUREMENT...

THE PARSHALL FLUME measures fast or slow moving water accurately, easily read from a standing position, no recalibration required for self cleaning, easy to install, maintenance free, lasts for years. Approved by State Engineers; eliminates disputes over water measurement. This simple, efficient, low cost flume available from our large stock; 3" to 36" throat widths. Larger sizes made to order.

Parshall Measuring Flumes

TP8-8

Write for free complete bulletins on these products.

THOMPSON PIPE & STEEL COMPANY

3017 Larimer Street Denver 1, Colorado Phone TAbor 5-1241

EQUIPMENT MATERIALS and METHODS

(continued)

and the boom rotates a full 360 deg.

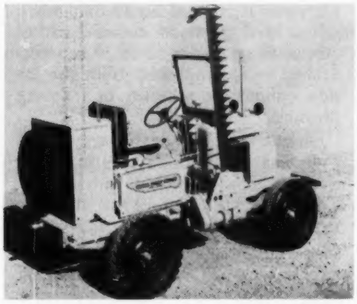
The new crane has controls on both sides. All boom and loadline actions, or any combination of them, can be accomplished simultaneously. It is available in three models. One has a fixed length boom, 12 ft long; the second has a boom that telescopes manually from 12 to 16 to 20 ft; and the third telescopes hydraulically from 12 to 20 ft.

Model 50 has hydraulic, "A" frame outriggers, the super-safety self-locking type. Power for operation of the crane is derived from the truck, through a power take-off and hydraulic pump: the pump is mounted directly on the power take-off, thus eliminating the need to run an underdrive system, greatly simplifying installation. **Pitman Manufacturing Co., CE-2, 300 West 79th Terrace, Kansas City, Missouri.**

Roadside Mower

NOT A TRACTOR ATTACHMENT, but a completely integrated machine designed and engineered for fast and economical mowing, the newly designed roadside mower has a heavy channel frame construction, permitting the use of a front end loader for stock pile work; one man can attach or remove the hydraulic mowing mechanism in 10 min.

A special interest is the fast on-and-off Chemical Power Sprayer attachment,



Completely Integrated Machine

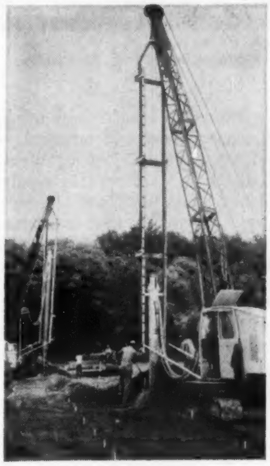
which sprays weed-killing chemicals along the fence line at the same time it mows.

Road travel speeds of 40 to 45 miles an hour give more actual mowing time each day and lengthen the life of the machine by having it under cover during bad weather, and available for servicing.

Mowing speeds are from 1 to 10 miles an hour; the slower speed makes it possible to cut green, woody vegetation that stops many mowers. **Topeka Hiway Mower, Inc., CE-2, 700 E. 8th St., Topeka, Kansas.**

Vibroflotation®

saved $53,000 over the use of piling for school foundation in New York State



Two Vibroflots made 704 compactions to depth of 20 feet at Colonie Junior High School. Each compaction consumed 7 or 8 tons of sand.

For Colonie Junior High School, Colonie, N.Y., 30-ton piles, 60 feet long would have cost $105,000. The total cost of Vibroflotation, plus stripping, was $52,000 to compact the soil to specified depth of 20 feet below footing grades. The complete operation took 22 working days.

Vibroflotation is one way to get more out of construction dollars for school and all types of structures.

Other schools recently built on sand compacted by Vibroflotation include: Three Florida Catholic schools in Pensacola, Orlando and St. Petersburg; four educational buildings at the new University of South Florida, Tampa; Bridgeton High School, Bridgeton, New Jersey; Marlow Heights Junior High School, Prince George's County, Maryland.

Write for Booklet C-18

Proven Applications

Deep Foundations • Dams
Bridges • Airports • Tunnels
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Industrial Foundations

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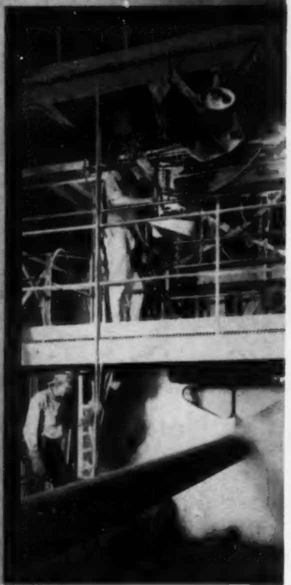
WATER PIPE
by SOUTHERN PIPE



STEAM
FOR STRENGTH

Southern Pipe's exclusive steam coating process means greater early strength, higher early set. Water pipe that sets stronger, quicker, is less liable to damage. There is no excess moisture; coating is less permeable. Customers get better corrosion protection.

Cement Mortar Lined and Coated Steel Pipe is one of many types of quality water pipe completely fabricated and processed in Southern Pipe's own plant.

Find out more about Water Pipe by Southern Pipe. Write for illustrated brochure.

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EQUIPMENT MATERIALS and METHODS

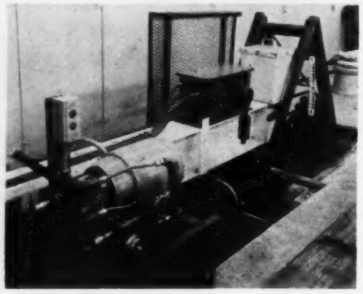
(continued)

Boom Pendant Tests

RECENTLY, A GROUP OF fatigue tests of boom pendants was run in a machine specially designed to reproduce as nearly as possible actual service conditions.

The first series testing various types of end terminals, using uncoated rope, found drop-forged swaged terminals to have the longest fatigue life of all end fittings tested.

The second group comparing uncoated, galvanized, and bethanized ropes utilizing the best end terminal as determined by the first test series, proved that the most favorable results were obtained with bethanized rope, that is, rope in which the individual wires are zinc-coated electrolytically and then drawn to finished wire size. These specimens lasted up to 400,000 test cycles before strand failure, or twice the number of cycles obtained with uncoated rope. **Bethlehem Steel Co., CE-2, East Third St., Bethlehem, Pa.**



Boom Pendant Testing Machine

Digital Recorder

TRAFFIC FLOW DURING ANY preselected time interval may be readily measured by a new digital recorder. Operated by electrical impulses from a conventional road treadle, the recorder produces a permanent record on punched paper tape. The tape recorder is easily interpreted visually or is suitable for use with automatic data processing machines.

The unit is an adaptation of the company's Digital Demand Recorder, which has a record of proved performance in demand recording and load survey work for electrical utilities. It is offered with standard time intervals of 5, 15, or 60 minutes. Other intervals are available and interval changes are easily accomplished by the user. **Fischer & Porter Co., CE-2, 911 Jacksonville Road, Hatboro, Pa.**

HIGH PRESSURE LEAKAGE CHOKED OFF WITH SIKA NO. 2

In tunnels, dams, deep basements and similar structures, Sika No. 2 will choke off tons of water under extreme pressure. It is a red liquid that, when mixed with portland cement, causes mortar to set within 15 to 30 seconds. Sealing is accomplished from the inside without the necessity of relieving pressure.

Moderate pressure leaks are sealed with Sika No. 4A. Mortar made by mixing this clear liquid with cement, will set within 45 to 60 seconds sealing seepage quickly and firmly.

Sika Quicksets produce an adhesive mortar that does not dilute or wash away. Very little heat is produced during hardening. Plugging is fast and dependable, thus saving both time and money.

For complete information on Sika Quicksets, write for Bulletin QS-57.

26-23

SIKA CHEMICAL CORPORATION
PASSAIC, NEW JERSEY

DISTRICT OFFICES: ATLANTA • BOSTON • CHICAGO DALLAS • DETROIT • NEW ORLEANS • PHILADELPHIA PITTSBURGH • SALT LAKE CITY — DEALERS IN ALL PRINCIPAL CITIES — AFFILIATES AROUND THE WORLD

EQUIPMENT MATERIALS and METHODS

(continued)

Photo-Sensitive Chart Material

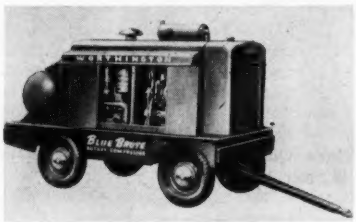
A VERSATILE NEW PHOTO-SENSITIVE chart material for ultra-accurate projection gaging has been announced.

Known as the Kodak Translucent Plate, Type 5, the new material will make possible tighter tolerances, improved accuracy and lower inspection costs in projection gaging.

Embodying the dimensional stability of glass, the accuracy of photographic reproduction and "automatic" preparation capabilities, the new plates are also expected to enhance intra-industry and interplant inspection procedures. For example, multiple projection charts may be made directly from scaled engineering drawings employing standard photographic copying techniques. The plates may then be used on each of several optical comparators, simultaneously boosting inspection speed and insuring photo-exact accuracy of tolerance charts. **Eastman Kodak Co., CE-2, Rochester 4, New York.**

Rotary Compressor

FEATURING THE "OVER-UNDER" DESIGN, the Model 365 cfm Blue Brute Rotary Compressor incorporates a unique method of construction that puts the second stage compressor cylinder directly over the first stage. The new unit is equipped with self-draining cylinders, a silent chain drive that is rated for 20,000 hours of life, and two filters, one being a lifetime filter and the other an inexpensive, replaceable final filter. The outboard end of each cylinder is exposed, thus every moving part of the compressor is easily accessible.



"Over-Under" Design

There are five automatic controls that eliminate high discharge air temperature; engaging the clutch while the engine is running; over heating of coiling water, etc. The unit is powered by a Cummins model NHC-400 engine. **Worthington Corp., CE-2, 426 Worthington Ave., Harrison, New Jersey.**

F/S DISTRIBUTORS: The A. Lietz Co., San Francisco and Los Angeles, Calif.—National Blue Print Co., Chicago, Ill.—Watts Instruments, Columbus, Ohio—Geo. F. Muth Co., Inc., Wash., D. C.—CANADA: Instruments 1951 Ltd., Ottawa, Toronto, Regina, Montreal.

FOR TRULY

UNDISTURBED SAMPLES FROM DIFFICULT FORMATIONS

ACKER-DENISON CORE BARRELS

THE ACKER-DENISON CORE BARREL PERFORMS WHERE OTHERS FAIL

The ability of the Acker-Denison Core Barrel to obtain **undisturbed samples** from sand, hard clays, silt and other difficult cohesive soil conditions accounts for its worldwide acceptance by Soil Engineers.

ACKER-DENISON CORE BARREL —PROVED AND IMPROVED

While the basic features of the original Denison are duplicated in the samplers manufactured by Acker, numerous improvements suggested by Acker's 40 years of soil sampling experience are incorporated in the new Acker-Denison. It is these improvements that make the Acker-Denison even more useful and efficient than before!

Remember, no other manufacturer can offer the improved performance and exclusive patented features of Acker's new Denison Core Barrel. This proud achievement of Acker development and progress is exclusively Acker!

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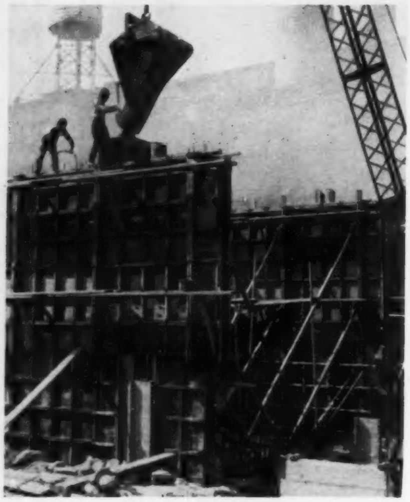
ACKER DRILL CO., INC.
P. O. BOX 830 • SCRANTON 2, PA.

CUT CONCRETING COSTS WITH Richmond FORMING METHODS



You can save time and money by making forms with your lumber and Richmond Form-Tys and Accessories.

Setting, pouring and stripping forms goes faster when you use the Richmond Snap-Ty Form System. With this system you can build your own prefabricated panels. Form erection is reduced to an assembly procedure of the reusable low cost panels into durable forms suitable for continuous pours.

RICHMOND SNAP-TYS

FOR TYING LIGHT CONCRETE FORMWORK

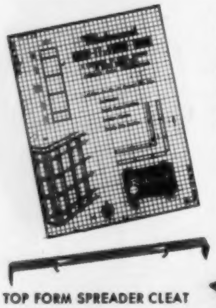
½" or 1" BREAK SNAP-TY ASSEMBLY—3000 LB. OR 5000 LB. SAFE LOAD

Richmond Snap-Tys are specifically designed for quick, easy and accurate erection of light foundation wall forms. With Richmond accessories they will give you a worthwhile saving from start to finish.

Spreader washers of ample size are precisely located to give the exact wall thickness. Head washers of special steel are securely held by a clean, well formed upset on each end of the tie to give positive bearing on the Tyholder, thus transmitting the full strength of the Snap-Ty to the walers and preventing the possibility of costly breaks.

Break points are set back from the wall face to permit easy, clean stripping and prevent spalling of the concrete. The small tie holes and indentations of the washers, or cones if they are used, are easily pointed.

Richmond Snap-Tys are available with safe loads of 3,000 lbs. and 5,000 lbs.



Richmond does not make, sell or rent forms. Richmond sells Form-Tys and accessories and shows you how to make your own forms which can be used over and over. Profit by this fast, easy method for erecting light foundation walls. Send for your FREE copy of the Richmond Snap-Ty Form Book, containing complete diagrams and forming data. At the same time, ask for the current Richmond Handbook, which describes the full line of Richmond-engineered tying devices and accessories.

Write to: Richmond Screw Anchor Company, Inc.
816-838 Liberty Ave., Brooklyn 8, N.Y.
or 315 South Fourth St., St. Joseph, Mo.

Some of the new accessories developed by Richmond for easy on-the-job assembly of prefabricated modular form panels.

EQUIPMENT MATERIALS and METHODS

(continued)

Electronic Transistorized Motor Operator

A NEW ELECTRONIC TRANSISTORIZED Motor Operator for individual proportional applications, designed for damper and valve control in heating, ventilating and air conditioning systems, has been added to the company's motor operator line.

Compactness and simplicity never before realized are made possible through application of transistor components in the electronic circuitry of the new transistor operator.

Electronic Flexibility

Electronic flexibility—meaning choice among sensing elements, selection of compensated control, wide adjustability of range and ratio settings—is part of the package the company offers in this motor operator.

Virtually self-contained, the simple attachment of a two-wire sensing element to a transistor operator forms a system of electronic control. It is easy to use, as connection to any convenient 115-volt power source completes the installation. **Barber-Colman Co., CE-2, 115 Loomis St., Rockford, Ill.**

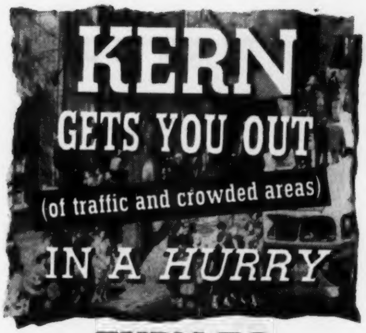
Snow Plow Blade

EASILY ATTACHED AND SELF-ADJUSTING to any type of wheel and crawler tractor, this new reversible angling blade is the only one of its kind on the market, the manufacturer states.

A system of pins and holes in the longitudinal back brace gives the blade its unusual adaptability. By simply moving the securing pins to appropriate holes, the blade can be mounted on any type of wheel and crawler tractor in a matter of minutes.

Several other important features are:

(Continued on page 133)



TURN TO
KERN INSTRUMENTS
for increased working speed, simplicity and economy of operation, higher degree of accuracy.

45 SEC. SET-UP TIME with KERN GKI LEVEL and KERN (Ball & Socket) TRIPOD

- **Unique new design—no leveling screws.**
- **Compact, functional, highly portable.**
- **Fast, effortless operation.**
- **Fine tilt screw; coincidence spirit level.**
- **Mean accuracy as high as 13/1000 ft. per mile.**

$251.50 GKI LEVEL
Including Fixed Leg Tripod

★

REVOLUTIONARY NEW TRIPOD
Levels instrument with remarkable speed. Assures exceptional stability with ball-and-socket head supporting instrument coupling.

★

Write for Brochure GK 479-2
PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL

Kern SWISS
The FINEST in SURVEYING EQUIPMENT
KERN INSTRUMENTS INC.
120 Grand St., White Plains, N.Y.

EQUIPMENT MATERIALS and METHODS

(continued)

it can be angled to either side up to a maximum of 42 deg; its two oscillating swivel runners maintain proper position of blade; and shock and strain on the main frame are reduced by three heavy duty torsion springs, which deflect the blade on contact with immovable objects such as manhole covers. **General Engines Co., Inc., CE-2, Route 130, Thorofare, New Jersey.**

Power Digger

Claiming to average 150 ft per hour in digging ditches with the Sherman Power Digger under normal conditions, Vernon O. Lippoldt, co-owner of the D & L Ditching Service, Haysville, Kansas says it took him 15 minutes recently to dig a 4-ft x 8-ft x 8-ft hole.

The company uses this equipment for footings, sewer ditching, septic tank excavations, laying cement pipe storm drains, concrete and tin culverts, and even cleaning out ditches at the ends of the culverts where the township's maintenance machinery is unable to get.

Panther

The fifth Power Digger the firm has purchased is a Panther, which can dig 10 ft deep with absolutely no trouble and which has dug ditches 12 ft deep with ease. **Sherman Products, Inc., CE-2, 3200 W. 14 Mile, Royal Oak, Mich.**

Colorlith

Vast new opportunities for builders of commercial structures, research centers, schools, hospitals and other institutions are seen in a leading architect's evaluation of an asbestos-cement material confined until recently to laboratory table tops.

Colorlith is a mixture of Portland cement and carefully selected asbestos fibers integrally combined with chemically resistant colorings and fillings. It is

(Continued on page 134)

LABYRINTH WATERSTOPS

A SOUND INVESTMENT FOR CONCRETE CONSTRUCTION!

LABYRINTH AVAILABLE IN 2, 3 or 4 rib.

ON YOUR CONSTRUCTION:

1. Consider the investment in design, materials and labor (to mention a few).

2. Then consider how important safe, secure *watertight* concrete joints are.

3. Thorough watertightness *can* be secured by installing Labyrinth Waterstops —a dividend that makes the low initial cost of the product insignificant when compared to your total investment—and one that insures watertight concrete joints for years!

- Corrugated ribs grip concrete, insure an everlasting bond between joints.
- Finest polyvinyl plastic resists chemical action, aging, severe weather.
- Takes just seconds to nail to form . . . easy to cut and splice on location (prefabricated fittings available).
- There's a Water Seal product for every type of concrete work!

If your aim is to stop water seepage, *stop it effectively with Water Seals' Waterstops!*

"See Us in SWEET'S"

New Literature and Free Samples Sent on Request—Use Coupon Below

WATER SEALS, inc.
9 SOUTH CLINTON STREET, CHICAGO 6, ILL.
Made in Canada for J. E. Goodman Sales, Ltd. Toronto, Ontario

WATER SEALS, INC. DEPT. 1
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Chicago 6, Illinois
Please send free sample and descriptive literature.
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Company________
Address________
City______ Zone____ State______

subjected to enormous hydraulic pressure to form a dense, homogeneous sheet whose surface can be polished to a high degree of smoothness while retaining a soft textured appearance.

At least twice as strong as stone, it comes in readily workable 4-ft x 8-ft sheets in thicknesses of ¼ in., ⅜ in., ½ in., ¾ in., 1 in., and 1¼ in. Because of its exceptional structural strength, Colorlith can be used for laboratory table tops in sheets thinner than the conventional 1¼ in. **Johns-Manville Corp., CE-2, 22 E. 40th St., New York 16, New York.**

New "Payloader"

The load carry capacity of the new rubber-tired, four-wheel-drive H-90 "Payloader" is 9,000 lb at average travel speeds. Both gas and diesel power units are offered.

An important feature provides the most noticeable change in the appearance of this model. It is the "low-profile" front shroud which gives the operator improved visibility and makes for easier, faster and safer operation.

Easier, Faster, Safer Operation

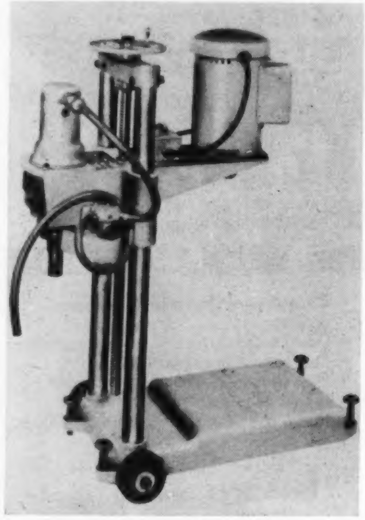
The "Payloader" has a breakout force of 21,000 lb and a bucket tipback of 44 deg at ground level. The patented pry-out bucket action is exclusive on rubber-tired loaders with machines produced by the company.

Power-transfer differentials, which automatically transfer up to 24% more torque to the wheels with the best footing under slippery conditions, are another feature of the new machine. **The Frank G. Hough Co., CE-2, 938 Seventh St., Libertyville, Ill.**

Diamond Bit Drilling Machines

Combining complete portability with fast, smooth cutting and easy, one-man operation, the new Kor-It Machines permit drilling speeds up to 1 in. deep per minute in reinforced concrete, granite, fused quartz, tile and asphalt paving.

Already in use on many construction, maintenance and machinery installation drilling jobs, the machines are reducing job time to a fraction of that required with ordinary equipment. One man can produce clean, smooth cores for foundation and road tests—holes for heavy industrial mountings are drilled to exact size the first time with no costly forming or chipping—feeder line openings on large sewer projects can be drilled after the main line has been laid, eliminating the need for extra joints.



Reduces Job Time

Available in 5 models for gasoline, electric or air operation, the drilling machines are the only equipment of this type having interchangeable motors. The heavy counter balanced base and precision machined upright columns and drill head are designed into one, compact unit which will accommodate any one of the three power plants or engines. **The Kor-It Co., Inc., CE-2, 314 Cottman St., Jenkintown, Pa.**

Light Weight Air Hammer

According to the manufacturer, the Model SP-900B light weight air hammer attaches "push-on" fasteners (such

(Continued on page 135)

POSITIVE FOOTING, LIGHT WEIGHT

Serrations scientifically designed to provide maximum positive footing and traction. High strength to weight ratio, minimum deflection, maximum safety, corrosion resistant. Bars cannot turn, twist, loosen or fall out. Write for complete details.

*Patents Pending

Gary SUPER Galok aluminum grating also available with plain bars. Both the serrated and plain types in sizes for every need.

ROCKWELL-STANDARD
CORPORATION
GRATING DIVISION
4053 E. Seventh Ave., Gary, Indiana

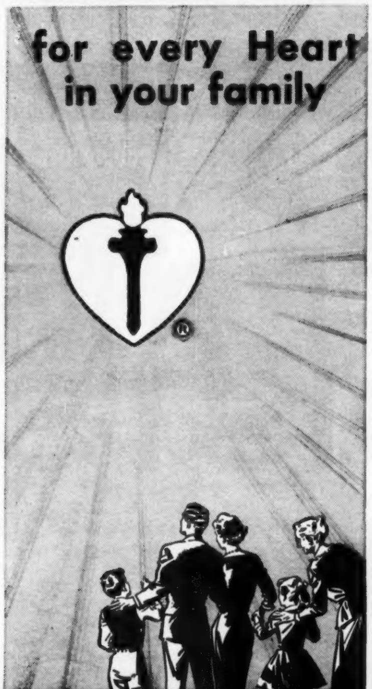
THE BRUNTON* POCKET TRANSIT

IT'S HANDY...
weighs only 9 oz.; 2¾" x 3" x 1⅛"; easy to carry in pocket, on belt, in car.

IT'S VERSATILE...
ideal for preliminary and supplementary surveying; used as a compass, transit, level, plumb, alidade, clinometer.
Shows direction to 1°; level, slope or grade within 1°.

IT'S MADE TO LAST A LIFETIME
"Over 60,000 Brunton Transits since 1896"
See your local engineering supply house or WRITE FOR CATALOG
*Brunton is a registered trademark of

WM. AINSWORTH & SONS, INC.
2151 LAWRENCE ST. • DENVER 5, COLORADO



EQUIPMENT MATERIALS and METHODS

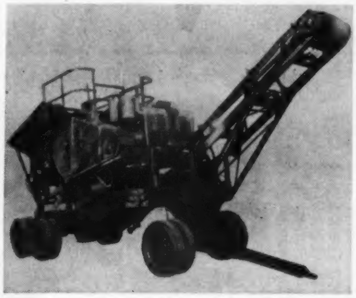
(continued)

as "Pal-Nuts" or "Speed-Nuts") uniformly in ⅓ the time taken by ordinary hand methods. Since the unit is light weight, assembly personnel can operate it easily without tiring. Weighing just 20 oz, it uses only 6.5 cfm at 90 psi. **Superior Pneumatic & Mfg., Inc., CE-2, 4758 Warner Road, Cleveland 25, Ohio.**

Portable Crushing Unit

Designated the 151PR, this unit has a 2036 overhead eccentric jaw crusher and a 3-ft x 8-ft apron type feeder, chain driven, with clutch, from the crusher. A wide delivery conveyor, 19 ft long, completes the components, all mounted on semi-trailer type chassis.

The jaw crusher, with 20-in. opening is of the long-jaw type and has the newly developed hydraulic-shim adjustment for crusher setting through a range of 2½ in. or 3 in. to 6 in. The crusher is installed on the chassis at an angle that directs the material into the crushing chamber along the natural lies of flow from the feeder, thus aiding the forced feed action, relieving bridging and reducing void spots in the crusher.



151PR

The feeder is of an improved design also, as the ½ in. forged steel slats ride on chains carried on steel rollers mounted on heavy channel-iron supports; the hopper sides are sloped and braced to the bottom of the feeder mounting sills. **Pioneer Engineering, CE-2, 3200 Como Ave., Minneapolis 14, Minn.**

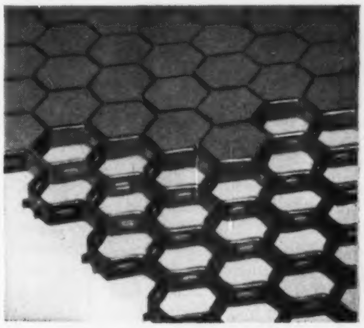
Test Pump

Used by pipe fitters to test piping installations, this versatile pump is being applied to numerous other uses, such as testing boilers, casings, radiators, removing obstructions from drain

(Continued on page 136)

"GRIDSTEEL"
Pays for itself!

...You save two ways with
IRVICO "Gridsteel"
1. Initial low cost
2. Reduction of floor maintenance costs



"Gridsteel" protects floors from the damage normally caused by impact, skidding, vibration and heavy traffic. "Gridsteel" is made of steel bars on edge, joined together in a honeycomb mesh pattern. No potholes or ruts can form because any crack in the fill cannot spread beyond a single steel mesh.

"GRIDSTEEL"
will protect floors made of wood, concrete, or asphalt.

Write today for complete information
Ask for 20-page color catalog on "Gridsteel" Floor Armor
★
"A Fitting Grating for Every Purpose"

IRVICO

IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at
5008 27th St., LONG ISLAND CITY 1, N. Y.
1808 10th St., OAKLAND 23, CALIFORNIA

pipes, forcing boiler compound into boilers, setting and checking relief valves, and for emergency boiler feed service.

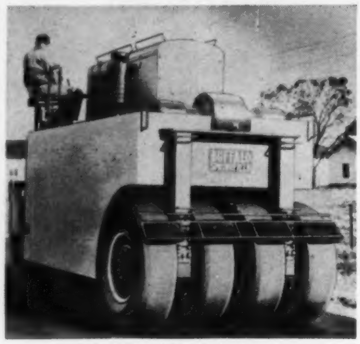
The Fig. 594 can exert pressures up to 400 lb and is fitted for iron pipe connection, ¾-in. suction, ¾-in. discharge; its height is 11½ in. **The Deming Co., CE-2, 42 Broadway, Salem, Ohio.**

Pneumatic Tire Roller

Compaction of sub-base, base, and finish (asphaltic concrete) courses of flexible type pavements are a few of the job applications of the self-propelled pneumatic tire roller. The manufacturer also recommends the new 10-30-ton, 7-wheel unit, designated the model PSR-30, for compaction of embankments for highways, airport runways, dams and building sites.

A special transmission, including torque converter, offers three speed ratios and an infinite range of rolling speeds up to 19.4 miles per hour, forward and reverse; speed shifting and reversing clutches are hydraulic actuated.

Two braking systems, for service and parking, are a safety feature. Each of the four drive wheels have double-shoe type, self-energizing brakes, hydraulically actuated, through air booster, by means of a foot pedal control. The parking brake is a double-shoe, mechanical type, on the transmission output shaft, controlled by a hand lever with a ratchet lock. **Buffalo-Springfield Roller Co., CE-2, 1210 Kenton St., Springfield, Ohio.**



Two Braking Systems

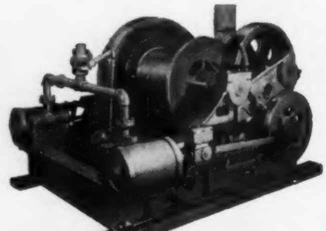
New Car Battery

According to the manufacturer, the "Cellomatic" is the first really new kind of storage battery that has been invented in the last 30 years. The result of more than five years of research and development under all conditions, it is completely different in appearance and will offer the motoring public advantages in performance and length of service that are impossible with types of batteries now on the market.

The new battery features high-impact, non-porous polystyrene cells in an equally rugged polyethylene frame. Both cells and frame are far stronger than those of conventional hard rubber or composition batteries, and will not crack or warp even at the most extreme temperatures. Also, the non-porous cells will not permit the electrical charge to leak out.

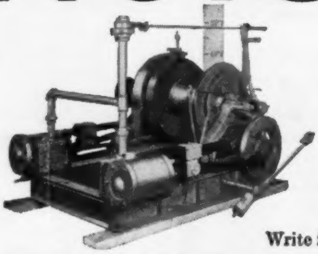
A major advantage of the "Cellomatic" is that each individual cell can be replaced at moderate cost in minutes, eliminating the necessity of buying a new battery when only one cell is not operating. **Scranton "Cellomatic" Battery Corp., CE-2, Archbald, Pa.**

THE TREND IN DRAFTING ROOMS THROUGHOUT THE WORLD IS TOWARD IMPERIAL, THE WORLD'S FINEST TRACING CLOTH



Single Drum
Double Drum
Specials

STEAM HOISTS



A specialty of Superior-Lidgerwood-Mundy Corp. who can supply any type or size of Steam Hoist you may require. Make your next Steam Hoist a Lidgerwood for dependability.

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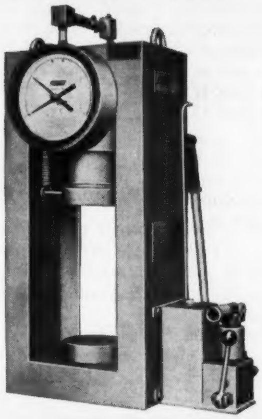
MODEL FT 20
JOBSITE
CONCRETE TESTER



FOR: CYLINDERS, CORES, BLOCKS, BEAMS, CUBES, BRICK AND DRAIN TILE
FORNEY'S INC.
TESTER DIVISION
BOX 310, NEW CASTLE, PA., U.S.A.

ECONOMY STEEL FORMS
used on Los Angeles' $6 million Sports Arena

By renting Economy Steel Forms for large jobs, working capital is freed for other needs. Economy Forms are supplied with supervisory service. Quickly lock together with a simple twist of a clamp. Save time, money, materials — increase profits.

FORMS FOR RENTAL OR PURCHASE

Economy Forms Corp.
Box 128-G, H. P. Station
Des Moines, Iowa

Please send catalog on Economy Steel Forms, and address of nearest sales office (there are 24 coast-to-coast).

Name ____
Firm name ____
Street address ____
City ____ State ____

EQUIPMENT MATERIALS and METHODS

(continued)

New Transcrete Truck Mixers

THE 1959 TRANSCRETES OFFER a new simplified design that reduces mixer weight and greatly increases payload.

This new design, combined with the use of new welding techniques and stronger, lighter weight alloy steels, provides the user with a stronger, more rugged and durable mixer.

Performance-wise, the machines feature a new drum blading design that provides faster no-flash-back charging and faster controlled discharge. According to the company, timed pours made on the job averaged less than 30 sec per yd for 1½-in. slump concrete.

New Drum Blading Design

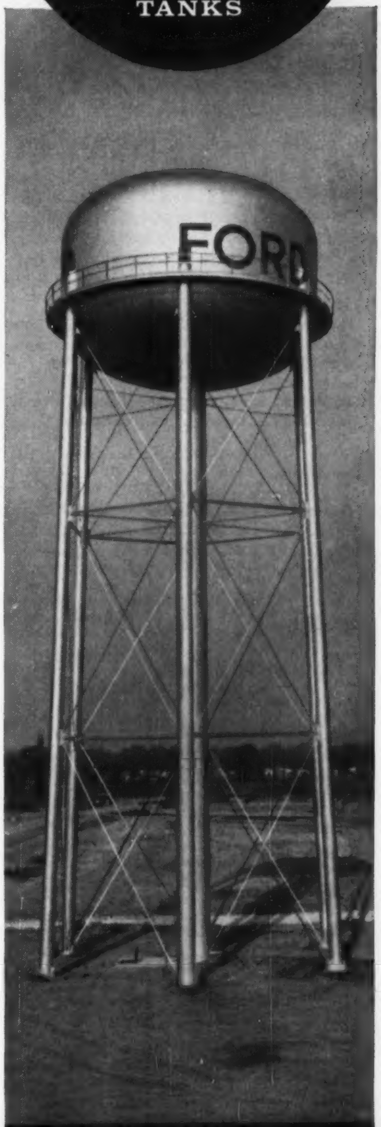
Other improvements include: drum redesign that offers increased carrying capacity; new, simplified 2-lever controls that give the operator control of the throttle, drum rotation direction, clutch and automatic drum brake at either end of the mixer; new 16-in. wide chutes that are stronger, yet weigh 20% less; and a permanent type fold-over chute section that may be quickly detached without removing any pins or bolts. **Construction Machinery Co., CE-2, Arts & Crafts Bldg., Waterloo, Iowa.**

Free Slide Rule

A HANDY CIRCULAR SLIDE RULE for engineers and other plant and office executives has been introduced. Any executive who must perform simple calculations will find this convenient, pocket-size calculator extremely useful in his work.

Operation of the rule is simple and the results are accurate; to multiply, divide and find proportions is easy and exceptionally fast. Complete easy-to-follow instructions will be included with each slide rule. To those who do not qualify as an engineer or other business executive to receive a free slide rule, the company will be pleased to send **one for 50¢. General Industrial Co., CE-2, 5738 Elston Ave., Chicago 30, Ill.**

INDUSTRIAL PLANTS RELY ON GRAVER® ELEVATED WATER TANKS



The Dependable Source

GRAVER TANK & MFG. CO.
DIVISION—UNION TANK CAR COMPANY
EAST CHICAGO, IND.
Plants and Offices Across America
for Elevated Water Tanks

In the field of

HYDRAULIC DREDGING

GAHAGAN

a leading name for over 50 years

Gahagan Dredging Corporation, 90 Broad Street, New York 4, N.Y. Write, wire, or phone Whitehall 3-2558. Cable "Walgahagan".

PHOENIX BRIDGE COMPANY

Engineers
Fabricators
Erectors

Structural Steel
BRIDGES and BUILDINGS

General Office
and Shops

PHOENIXVILLE, PA.

Subsidiary—Barium Steel Corporation

EQUIPMENT, MATERIALS and METHODS

(continued)

Crawler Erecting Crane

THE PRINCIPAL FEATURES OF the Model 1010 crawler erecting crane are maximum stability combined with a lifting capacity of 100 tons with a 60-ft boom at 15-ft radius.

The 16-ft 10-in. wide crawler assembly is constructed of alloy steel with rugged integral axle extensions. The wide spread lower feature provides the required stability to handle 200 ft of heavy-duty boom or 300 ft of light weight boom for concrete work.

Maximum Stability

Power for the swing is transmitted electro-magnetically through P&H exclusive magnetorque, thus doing away with the need for friction swing clutches, eliminating lining replacements, adjustments and maintenance required with conventional assemblies. It is said to produce faster work cycles, increased production and reduced operator fatigue. **Harnischfeger Corp., CE-2, 4400 West National Blvd., Milwaukee 46, Wis.**

Conveyor Belt

THE BIG CONVEYOR BELT which was installed in 1953 at the Maple Grove, Ohio, plant of Basic Inc., is still in good condition after carrying more than 10 million tons of crushed stone up to 6 in. size. The rock moves at a rate of 380 ft per minute up an 18-deg incline from the primary crushing plant to a surge pile that feeds the secondary crushing plant. Thirteen to fifteen tons of stone are carried at any given moment and well over 600,000 tons are moved in peak months.

The conveyor belt is 794 ft long and 36 in. wide and is made of 5-ply friction-coated and skim-coated 48-oz duck with a 3/16-in. rubber top cover and breaker strip, and a 1/16-in. bottom cover. **New York Rubber Corp., CE-2, 100 Park Ave., New York 17, N. Y.**

Pipeline Pump

THE INTRODUCTION OF A NEW submersible pipe line booster pump which is designed to operate in a horizontal position within the pipe line itself has been announced.

Named the "Power-Line", the pump's exclusive design enables it to be suspended within a special section of the pipe line. This section is flanged at each end and becomes an integral section of the pipe line. The motor is centered and firmly held by special spiders within this section. The line liquid is drawn past the motor and into the bowl assembly which passes it along at greatly increased pressure. The submersible power cable leads to a terminal box mounted on the outside of the special section and from there runs to a control box.

In addition to the normal submersible advantages of noiseless operation, economy and dependability, the pump also completely eliminates the need for pump houses, additional property, motor damage from heat, dust and moisture, vandalism and all stuffingboxes or packing glands. **Layne & Bowler Pump Co., CE-2, Vail at Sycamore, Los Angeles 22, Calif.**

Heavy Duty Grouser Plates

A COMPLETE LINE OF heavy duty wear resistant grouser plates for all standard model crawler tractors is now available. These plates have an initial hardness far in excess of regular manganese steel and the added ability of developing an even greater degree of surface hardness in the areas where continued wear and abrasion cause the most trouble.

Available in regular, flat and semi-grouser types to fit all of the more popular tractors, they are completely interchangeable with those originally mounted on the tractor.

Some features which have been incorporated in the plates are: beveled grouser cleats that produce less resistance to steering clutches and braking mechanism; the plates are heavied up at all critical points to better resist bending and breaking; and countersinking of all holes in the plate eliminates the wearing action on the bolt head. **Kensington Steel Div. of Poor & Co., CE-2, 505 Kensington Ave., Chicago 28, Ill.**

Literature Available

SWIMMING POOLS.—"Modern Swimming Pools of the World" by Dr. Dietrich Fabian, Technical Advisor on Olympic Standards, is a beautifully-illustrated 148-page book which contains 181 pictures, 208 plans of instruction for constructing indoor and outdoor pools, and 7 construction-tables. Some of the types of pools pictured include: instruction pools in schools, outdoor pools with separate units, small indoor pools, and instruction pools in municipal indoor pools. The price is $10. **National Pool Equipment Co., CE-2, Lee Highway, Florence, Alabama.**

UNIVAC FLOW-MATIC—According to this 8-page brochure, one of the chief advantages of the Univac Flow-Matic System is that the use of English words describing the processes and the items concerned permits various levels of management and people most familiar with the business processes to transmit their ideas from system flow charts directly into the running programs. The Flow-Matic is instrumental in reducing program preparation time, as the task of writing C-10 coding can be replaced by writing English pseudo-code, which can be easily taught to clerical workers. **Remington Rand Univac, Div. of Sperry Rand Corp., CE-2, 315 Fourth Ave., New York 10, N. Y.**

SERVICES & PRODUCTS—This 19-page brochure offers some insight into the background and operations of the firm, with a primary emphasis on its operation as a drilling contractor. Foundation investigation, mineral exploration, pressure grouting and the various miscellaneous services are described and illustrated. The manufacturing and equipment sales functions are also covered, and several new items of drilling equipment are announced for the first time. For example, the Wire Line Core Barrel will permit recovery of a larger core in relation to the hole size than is normally associated with wire line equipment. **Sprague & Henwood, Inc., CE-2, Scranton 2, Pa.**

SLIDE RULES—Entitled "Slide Rule? May I Help . . .", this 24-page booklet is a guide for the student or professional about to buy a slide rule. The two-color pamphlet describes scale designs and arrangements, the fine woods, glass and synthetic materials used in rule construction, and teaching aids and accessories for the slide rule. It also includes a wide variety of K&E rules. Some of these are: the Log Log Duplex Decitrig (the standard slide rule most widely used by engineers); the Polyphase and Mannheim types; special purpose models for businessmen, surveyors and radio engineers; and pocket versions of most standard rules. **Keuffel & Esser Co., CE-2, Adams & Third Streets, Hoboken, N. J.**

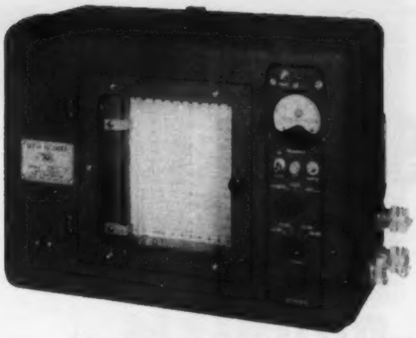
NOW NEW

Edo

MODEL 255C

SURVEY DEPTH RECORDER

more accurate, more versatile than ever



Hinged viewing window and housing which drops down to allow access to interior contribute to ease of operation and maintenance of Edo Model 255C Survey Depth Recorder.

EDO, acknowledged leader in the design and manufacture of echo-sounding devices, now offers a vastly improved Precision Survey Depth Recorder—Model 255C—for permanent or temporary installation aboard vessels of every size.

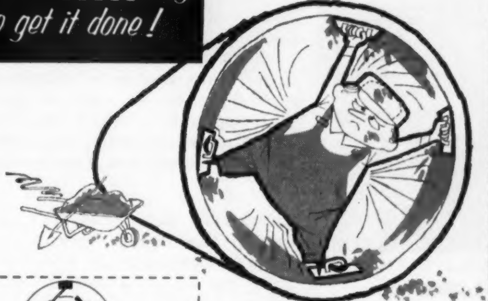
Extremely accurate, light in weight (only 55 lbs.) and easy to operate, Model 255C is the ideal recorder for deep depth, penetration and general underwater survey. Accuracy is within ½ of 1 per cent, in water depths from 1-½ feet to 230 fathoms. Bottom readings are recorded permanently and with knife-sharp definition on overlapping range scales, in feet or fathoms. Wide transducer beamwidth —20 degrees at minus 10 db points—assures excellent penetration and broad recorder coverage.

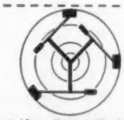
FOR CERTAIN SPECIFIC APPLICATIONS—such as underwater dredging and cable laying where detailed bottom contour information over a relatively small area is required—Edo also offers its new *Model 255D*. Conversion to the narrow beamwidth configuration (6 degrees at minus 10 db points) is achieved simply by the exchange of certain components of the 255C and substitution of a specially built transducer.

Send for new illustrated brochure, Dept. 2-V.

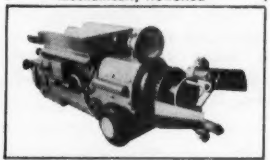
Edo CORPORATION, College Point, L. I., N. Y.

there's a better way to get it done!





Centrifugally applied and mechanically trowelled



Compact, mobile machine moves through the line

Centriline Process applies smooth, continuous leakproof lining to inside of 16" to 144" pipe lines "in place." Applicable to fresh or salt water, oil, gas or industrial waste lines. Eliminates interior corrosion and leakage. Restores full flow coefficients.

Write for full information TODAY!

For Dependable Pipe Line Service Call in the Specialists!

Specializing in Pipe Protection Problems • Tate and Centriline "In Place" Interior Cement Mortar Lining • "In Plant" and "Railhead" Centrifugal Spinning of Cement Mortar or Coal Tar Linings – Somastic® Exterior Coating • Pipe Wrapping • Reclamation: Removal of Old Wrapping, Straightening, Blasting, Beveling, Testing.

PIPE LININGS

A Division of American Pipe and Construction Co.

2414 East 223 St. (P. O. Box 457) Wilmington, California

STANPAT SOLVES THE GHOSTING PROBLEM

NEW resin-base STANPAT ELIMINATES GHOSTING,
offers better adhesion qualities on specific drafting papers!

THE PROBLEM
Some of our longtime customers first called our attention to the "ghosting" problem. Certain tracing papers contain an oil which could be leeched out by the STANPAT adhesive (green back) causing a ghost.

THE SOLUTION
A new STANPAT was developed (red back), utilizing a resin base which did not disturb the oils and eliminates the ghost. However, for many specific drafting papers where there is no ghosting problem, the original (green back) STANPAT is still preferred.

WHICH ONE IS BEST FOR YOU?
Send samples of your drawing paper and we will help you specify. Remember, STANPAT is the remarkable tri-acetate pre-printed with your standard and repetitive blueprint items—designed to save you hundreds of hours of expensive drafting time.

SO SIMPLE TO USE

1. PEEL the tri-acetate adhesive from its backing.

2. PLACE the tri-acetate in position on the tracing.

3. PRESS into position, will not wrinkle or come off.

STANPAT CO.
WHITESTONE 57, N. Y. **Dept. 89**
Phone: FLushing 9-1693-1611

STANPAT CO. Whitestone 57, N. Y. U.S.A.

☐ Enclosed are samples of the drafting paper(s) I use (identify manufacturer). Please specify whether Rubber Base or Resin Base STANPAT is most compatible with these samples.

☐ Send literature and samples of STANPAT.

☐ Please quote price on our enclosed sketches which we are considering to have pre-printed.

NAME__________

FIRM__________

ADDRESS__________

CITY__________

ZONE____STATE__________

Literature Available

Wash Water Valves—A new 4-page technical bulletin W-17 describing Surface Wash Water Valves for filters has been published. Used for surface wash water applications on filters and also for controlling the flow of water to the filters, these control valves are easily opened or closed from the operating table in the usual manner. Operating layouts, operation, construction and dimensions are included, along with complete specifications. **Golden-Anderson Valve Specialty Co., CE-2, 1207 Ridge Ave., Pittsburgh, Pa.**

Pile Hammers—A new 20-page engineering bulletin on the selection and application of single-acting pile hammers, using steam or air, with rated striking energy from 7260 to 30,225 foot pounds has been issued. Very comprehensive, it deals with many subjects such as rating of hammers, selecting size required, safe bearing load for piles, adaptability for driving, bases, plates, driving heads, helmets, and head blocks. **Vulcan Iron Works, CE-2, 327 N. Bell Ave., Chicago 12, Ill.**

Tank Insulation Method—A new method of installing insulation and jacketing on large storage tanks for hot materials, at savings of 30% or more, is described in a 4-page brochure. The booklet shows how end-welded studs, on which insulation and either aluminum or steel skin are impaled, are applied directly to the tanks or on lightweight strips that are then tack-welded to the tanks. Besides reducing costs, the method is said to result in improved tank appearance. **Nelson Stud Welding Div., Gregory Industries, Inc., CE-2, 2727 E. 28th & Toledo Ave., Lorain, Ohio.**

Compaction Equipment—The information in this 16-page booklet was prepared to assist anyone who has previously had no opportunity to study the subject of soils and materials compaction, especially in connection with the construction of roads, streets, air strips and dams. Some of the types of compaction equipment discussed in the brochure are: 3-wheel rollers, tandem rollers, trench rollers, and pneumatic tire rollers. Photographs and a glossary of construction terms are also included. **The Galion Iron Works & Mfg. Co., CE-2, 265 Park Ave., W. Mansfield, Ohio.**

Aluminum Grating—This new catalog on aluminum grating contains load tables, engineering data and photographs of three types, Roll-Lock, Riveted and Pressure-Locked. Light weight, non-magnetic, and non-corrosive, the aluminum grating has no maintenance cost, and its high strength insures many years of service. **Kerrigan Iron Works, Inc., CE-2, 1030 Herman St., Nashville 2, Tenn.**

TIDE GATES

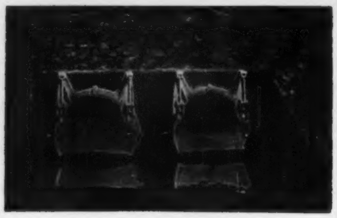


Fig. B-124-D
Two 60" Type M Gates on Relief Culverts near Woodward Pumping Station, Plymouth, Pa.

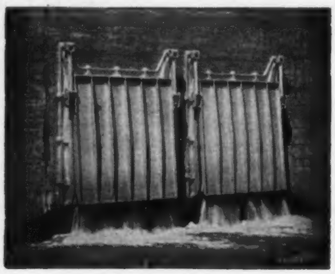


Fig. B-124-C
Two 72" x 72" Type M-M Gates on Toby Creek Outlet Works, Plymouth, Pa.

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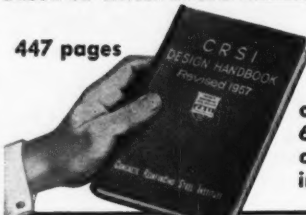

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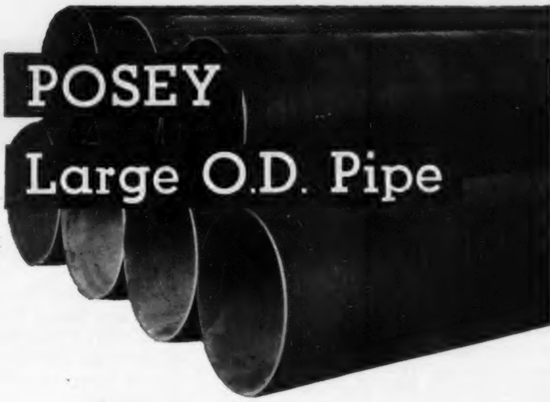
EXPANDS LINE: The addition of portable pneumatic grinders to its line of tube maintenance tools has been announced by Thomas C. Wilson, Inc. The firm is expanding into a new area of a field in which it has specialized for more than a quarter of a century as a major manufacturer of portable air-driven equipment . . . **NEW DEPARTMENT:** The Thermoid Co., well-known manufacturer of industrial and automotive rubber and friction products, has become an important part of the new Thermoid Div. of H. K. Porter Co. (Delaware), which will manufacture and market all products formerly made by Thermoid Co. and Porter's Quaker Rubber Div. . . . **OPERATIONS TRANSFERRED:** Dorr-Oliver Inc. has announced plans to transfer its filtration engineering and development operations from Oakland, Calif. to Stamford, Conn. Part of a long-range plan for centralization of all filtration engineering and manufacture in the east, the move will provide better service to customers through improved engineering and production communication . . . **NEW COMPANY FORMED:** Olin Mathieson Chemical Corp. and Textron, Inc., have announced the formation of a jointly owned company, Almetco, Inc., to produce aluminum extrusions for the two firms . . . **NAME CHANGE:** The John Ulrich Co. of El Paso, Ill., has been incorporated under the new name of Ulmac Equipment Co., Inc. . . . **PURCHASE ANNOUNCED:** Yuba Consolidated Industries, Inc., has purchased Southwest Welding & Manufacturing Co. of Alhambra, Calif. With plants in Alhambra and Richmond, Calif., Southwest Welding offers a complete service for the engineering, fabrication, and field construction of heavy equipment for the atomic energy, petroleum, chemical, power and hydroelectric industries . . . **NEW DEPARTMENT:** Simmonds Aerocessories, Inc. of Tarrytown, N. Y., announces organization of its Specialty Valve Dept., concentrating on design and manufacturing of mono and dual propellant valves for use primarily in the aircraft and missile field . . . **HEADQUARTERS MOVED:** Clayton Manufacturing Co., makers of dynamometers, steam generators, steam cleaners, and portable heaters, has moved its Cincinnati headquarters out of the congested city center area into a new multipurpose facility some 10 miles northeast of downtown, at 3051 Exon Ave., Evendale . . . **NEW ENGINEERING BUILDING:** The board of directors of the Four Wheel Drive Auto Co., Clintonville, Wis., manufacturer of heavy-duty trucks and other specialized vehicles, has approved construction of a new two-story engineering building, it was announced . . . **COMPANY ACQUIRED:** The acquisition by Vulcan Materials Co., Birmingham, Alabama, of Gary Slag Corp., Gary, Indiana, has been revealed. Vulcan is one of the nation's largest producers of building and construction materials . . . **DISTRIBUTORS APPOINTED:** Construction Machinery Mart, Div. of Strong, Carlisle & Hammond, has been appointed an authorized factory distributor for Delco batteries and Packard automotive cables . . . Wemco of San Francisco, Calif., has named the Cramer Machinery Co. of Portland, Ore., as distributor for its aggregate equipment in the state of Oregon and southern Washington . . . The G. C. Phillips Tractor Co., Inc., Birmingham, Ala., has been appointed exclusive distributor by the C. S. Johnson Co., Champaign, Ill. . . . **APPOINTMENTS:** Philip R. Hirsh, former Executive Vice President in charge of Sales for Lock Joint Pipe Co., has been appointed Chairman of the Board of Directors . . . Sedgwick Machine Works announces the appointment of Joseph M. Walsh as Western Sales Engineering Advisor assisting Sedgwick representatives in the West Coast and Mountain States . . . Edgar J. Griesbaum has been appointed Sales Manager of Tubular Products, Laclede Steel Co., St. Louis, Mo. . . . William Beavin has been made Sales Representative in Indiana and central Kentucky for the Pump & Well Supply Div. of Clayton Mark & Co. . . . The board of directors of the National Association of Blueprint and Diazotype Coaters has elected Herbert F. Bruning, president of the Charles Bruning Co., Inc., Mount Prospect, Ill., as president of the association.



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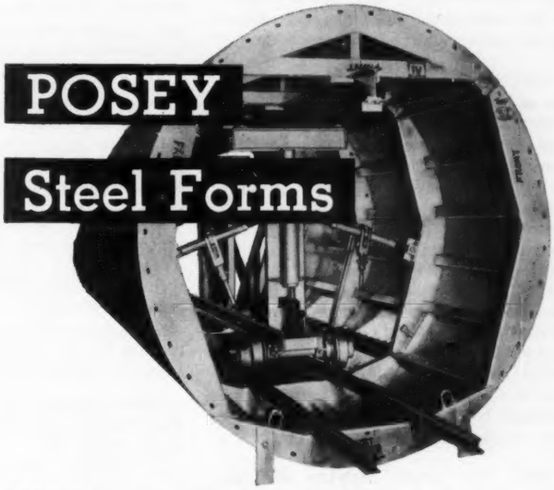

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JANUARY

Journals: Air Transport, Engineering Mechanics, Highway, Hydraulics, Pipeline, Structural, Sanitary Engineering.

1892. Meeting USAF Blast Fence Requirements, by Temple A. Tucker. (AT) This paper examines: (a) past blast-fence requirements and, (b) a new requirement generated by the B-52 and how the Air Force is meeting it.

1893. Compressive Strength of Compacted Snow, by Gunner S. Pedersen. (AT) Tests carried out with 10 cm cubes of compacted snow to determine the compressive strength and its variations with density are described.

1894. Vortex Formation and Resistance in Periodic Motion, by John S. McNown and Garbis Keulegan. (EM) Variations in coefficients of resistance and inertia have been correlated in laboratory tests on the basis of the interval required for the formation of a vortex.

1895. Applications of Electrical Analogs of Static Structures, by Frederick L. Ryder. (EM) This paper reviews problems concerning 3-dimensional frames, non-linear structures, partitioning of complicated structures to permit simulation on small analog instruments, applied deflections and thermal effects, and related experimental work.

1896. On Longitudinal Waves in an Elastic Plate, by E. Volterra and E. C. Zachmanoglou. (EM) The problem of dispersion of longitudinal waves in an elastic infinite plate is examined. Numerical results are compared with those obtained by applying the exact theory given by Lamb.

1897. The Elastic Stability of Thin Spherical Shells, by Gideon P. R. von Willich. (EM) Theoretical work relating to elastic buckling of thin spherical shells is reviewed. A theory is presented for determining buckling pressures of shallow thin spherical shells under external pressure.

1898. Simplification of Dimensional Analysis, by Charles C. Bowman and Vaughn E. Hansen. (EM) Two succesive methods for simplifying the conventional method of dimensional analysis are presented.

1899. Early Soil-Cement Research and Development, by Miles D. Catton. (HW) The scientific and engineering principles applied, and the testing procedures involved in the Portland Cement Associations research and development work on mixtures of solid cement are presented.

1900. Highway Traffic Estimation by Linear Programming, by E. L. Killin (HW) Linear programming may hold the key to obtaining solutions to traffic estimation problems. The resulting solution compared favorably with that arrived at by conventional methods.

1901. Radar For Rainfall Measurements and Storm Tracking, by Glenn E. Stout. (HY) The present status of research in the United States on the utilization of radar for measuring precipitation is reviewed.

1902. Interim Consideration of the Columbia River Entrance, by John B. Lockett (HY) Dredging to secure a 48-foot channel depth at the mouth of the Columbia River reveals the need for re-evaluation of forces controlling the entrance area.

1903. Air Model Studies of Hydraulic Downpull on Large Gates, by W. P. Simmons, Jr. (HY) Air model studies were used to determine the hydraulic downpull forces on a large fixed-wheel gate and on a slide gate. The applicability of air tests for this work is reviewed.

1904. Application of Snow Hydrology to the Columbia Basin, by Oliver A. Johnson and Peter B. Boyer. (HY) Applications to daily snowmelt and seasonal runoff forecasting for several sub-basins of the Columbia River are shown.

1905. Flow Testing by Ammonia Displacement, by Jack N. White and T. N. Thawley (PL) The history, equipment, techniques and procedures for the ammonia displacement method in developing and executing flow efficiency determinations for large diameter natural gas transmission lines are examined.

1906. Pipeline Construction in the Past, Present and Future, by James W. Hall. (PL) This paper considers improvements in the art of pipeline construction of large diameter, long distance oil and gas lines. Future developments are briefly outlined.

1907. A Boring Method for Pipeline Construction, by James C. Fisher. (PL) This paper describes a construction method for driving of pipes below ground surface by jacking and boring.

1908. Gilsonite Solids Pipe Line, by E. F. Fulkerson and J. E. Rinne. (PL) The features of a 72-mile solids pipe line, considerations affecting its design, construction, and problems that have developed are given.

1909. Strength of Reinforced Concrete Beams, by Sidney A. Guralnick. (ST) Rational interaction equations for the failure of plain concrete under stress are developed on the basis of Mohr's failure theory.

1910. Elastic Resistance of Reinforced Concrete Beams, by G. R. Swihart, J. R. Allgood and W. A. Shaw. (ST) A theory is presented for determining the static resistance characteristics of uniformly loaded reinforced concrete beams. Attention is given to predicting ultimate deflection.

1911. Design of Pitched and Curved Timber Diaphragms, by Henry J. Degenkolb. (ST) A review of the internal action of timber diaphragms is presented together with a study of the stresses caused by curving or sloping portions of the diaphragm to conform to common truss shapes.

1912. Timber Bridges on the Railways, by C. V. Lund. (ST) The use and advantages of timber trestles on railways are given. Specifications, features of design and construction, and a resume of

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current studies toward improved design are presented.

1913. Timber Fastenings, by Ralph H. Glass. (ST) This paper presents the role of fastenings in new construction methods for light framing, and a new "family" of light-gage devised for trussed rafter connections.

1914. On the Solution of Rigid Frames by the Column Analogy, by Thomas D. Y. Fok and Tung Au. (ST) This paper provides a proof for the application of the column analogy to the analysis of single-span rigid frames of any degree of redundancy.

1915. Load Considerations for Beams, by F. P. Drew. (ST) The cumulative duration of stress in railroad bridge stringers determined indicates that consideration may be given to increased fiber stresses in bending over currently allowable working stresses for trestles subjected to ordinary traffic.

1916. Discussion of Proceedings Paper 1658, 1659, (AT) W. K. Laing, G. S. Cooper, and Morris E. Adams on 1658. J. F. Newberg on 1659.

1917. Discussion of Proceedings Paper 1693 (EM) A. T. Matthews on 1693.

1918. Discussion of Proceedings Paper 1380, 1525, 1626, 1799. (HW) Elmer B. Isaak no closure to 1380. Jack E. Leisch closure to 1525. John G. Dempsey on 1626. William Zuk on 1799.

1919. Discussion of Proceedings Paper 1455, 1585, 1663, (HY) J. C. Stevens closure to 1455. C. O. Clark on 1585. Leo R. Beard on 1663.

1920. Discussion of Proceedings Paper 1577, 1677, (PL) M. B. McPhersen and J. V. Radziul on 1577. W. T. Ivey, John F. Schomaker on 1667.

1921. Discussion of Proceedings Paper 1179, 1274, 1461, 1533, 1534, 1678, 1703, 1715, 1717, 1777, 1782, 1848, (SA) Morris M. Cohn no closure to 1179. Sterling Brisbin no closure to 1274. J. C. Stevens and Richard Kolf closure to 1461. Gaurchandra Ghosh closure to 1533. C. G. Gunnersen closure to 1534. Herbert Moore on 1678. C. H. J. Hull on 1703. Louis Finaly on 1715. Edwin B. Cobb and Allen J. Burdoin on 1717. Samuel A. Greeley on 1777. Charles H. Capen on 1782. J. C. Stevens on 1848.

1922. Discussion of Proceedings Paper 1354, 1510, 1695, 1696, 1708, 1709, 1711, 1712, 1722, 1818, (ST). Robert E. McClellan no closure to 1354. Bengt Broms and I. M. Viest closure to 1510. Lydik S. Jacobsen, A. A. Eremin on 1695. Alfred L. Miller, Henry J. Degenkolb on 1696. Jacob Feld on 1708, 1709, 1711, 1712. Andrew Reti, Alexander Dodge on 1722. D.C. Gazis corrections to 1722. Homer M. Hadley on 1818.

1923. The Rapid Design of Beams in Torsion, by Cedric Marsh. (EM) This paper shows how simple beam formulas can be extended to deal with torsion and how, by considering torsional rigidity and torsion-bending rigidity separately, results of acceptable accuracy can be obtained.

1924. Construction and Use of Models in Highway Planning, by F. B. Crandall. (HW) Construction procedure and materials used in building scale models of projected highway interchange facilities and the use made of completed models in highway programming and planning are studied.

1925. The Highway Cost Allocation Study, by G. P. St. Clair. (HW) Determining costs and benefits derived from use of federal-aid highways by vehicles of different dimensions and weights is the objective. Benefits to non-users are also studied.

1926. Pipeline Instrumentation and telemetering Systems, by Michael D. Altfillisch. (PL) This paper describes and defines the basic elements required in measurement, control and telemetering systems. Intergration of these elements into complete systems is illustrated.

1927. Inventory of Highway Needs, by R. C. Blensly, (HW) The procedures employed in Oregon to develop the need estimate for 12 systems considered to provide highways, roads, and streets for 1975 traffic volumes are outlined.

1928. Vehicle Weight Phase of the Section 210 Study, by C. K. Glaze. (HW) This study examines truck weight and usage data as essential in highway design, administration, and finance. Weights were obtained at locations representative of the rural and urban federal-aid highway systems.

1929. Field Test of the Movement of Radioactive Cations, by Ben B. Ewing (SA) A synthesized radioactive waste injected into a confined permeable underground formation was traced by radioassay of samples from monitoring walls. Results were correlated with field-scale hydraulic flow tests and a laboratory investigation of ion-exchange properties of earth material taken from the same formation.

1930. Treatment of Liquid Radioactive Wastes, by Conrad P. Straub. (SA) A review is presented of the methods used in handling, treating, and disposing of liquid radioactive wastes in the United Kingdom and Europe.

1931. Water Pollution in our Changing Environment, by C. H. Atkins. (SA) The increase in water usage has brought many challenges in the control of water pollution. All concerned must do their utmost to conserve and protect our water resources.

1932. Radioactive Pollutants, Progress Report of Task Force VI of the Committee on Atmospheric Pollution of the Sanitary Engineering Division. (SA) This report recognizes the extent of the airborne pollutant hazards being created by the expanded use of radioactive tracers and energy. Maximum contrations, as well as survey methods, instrumentation, and cleaning devices are examined.

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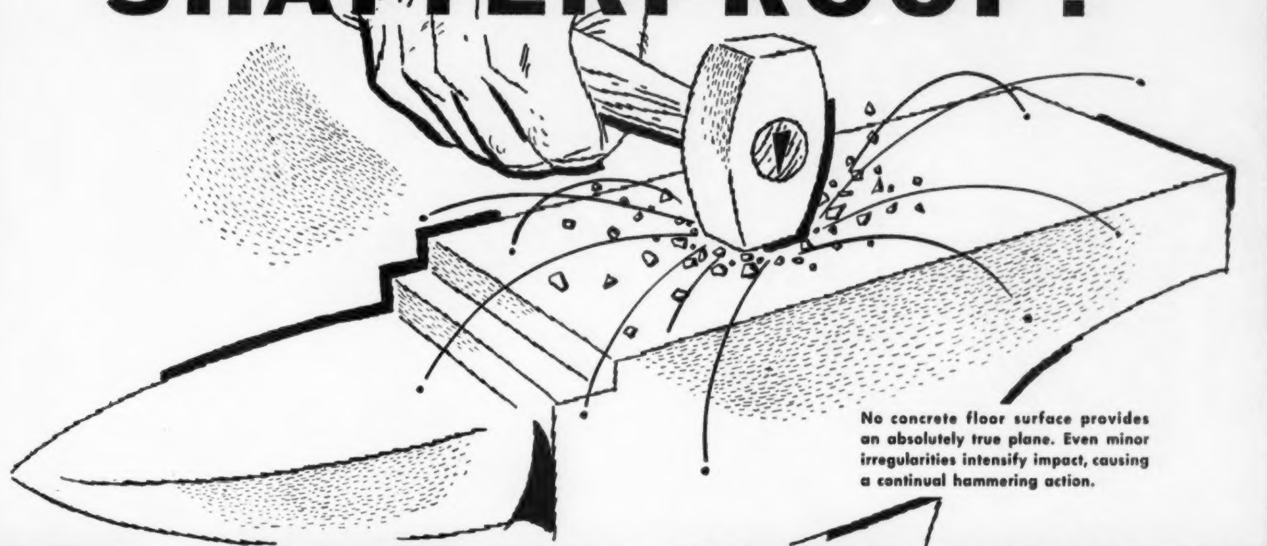

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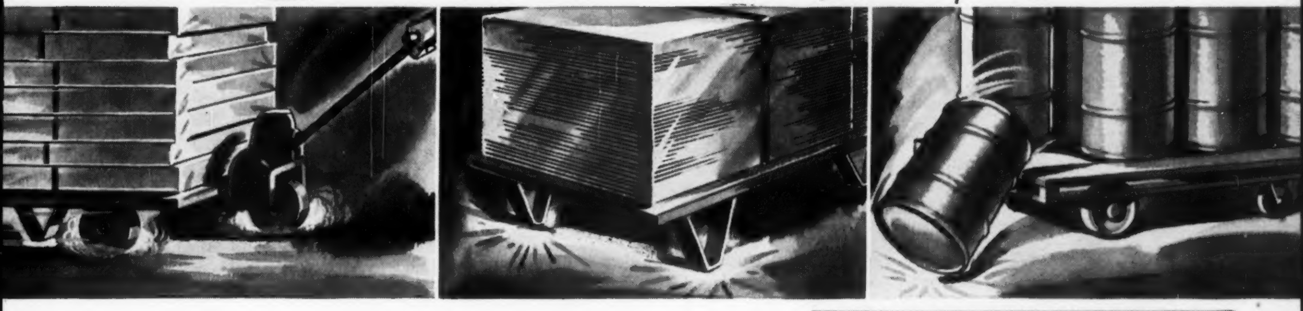

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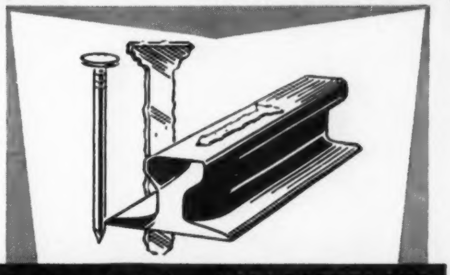

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New pipelines are essential; but only pipe of sustained high carrying capacity can meet greater demands with constant, predictable volume. That's why efficiency and economy dictate the use of LOCK JOINT CONCRETE PRESSURE PIPE for water supply and distribution lines. Its first low cost, ease of installation, long life, negligible maintenance and permanent high carrying capacity represent immediate and long term economies.

To bolster your water system against the shock of our yearly 3,000,000 increase in population, specify LOCK JOINT CONCRETE PRESSURE PIPE for complete dependability and over-all economy.

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